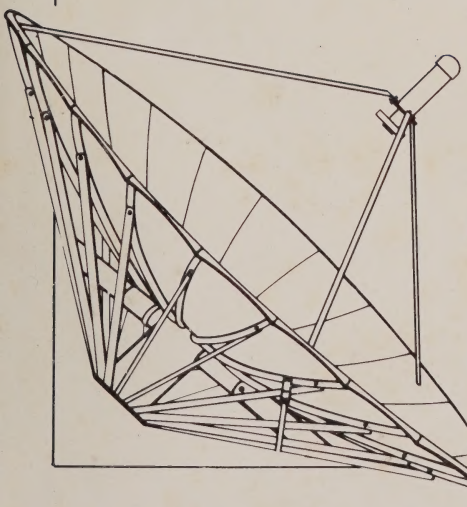
TOMORROWS TELEVISION TODAY

by Michael J. Stone



A HANDBOOK ON SATELLITE TELEVISION RECEPTION

£9.95
+£1.00 P&P PACKING

Michael J. Stone

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A Handbook on the Reception of Satellite Television.

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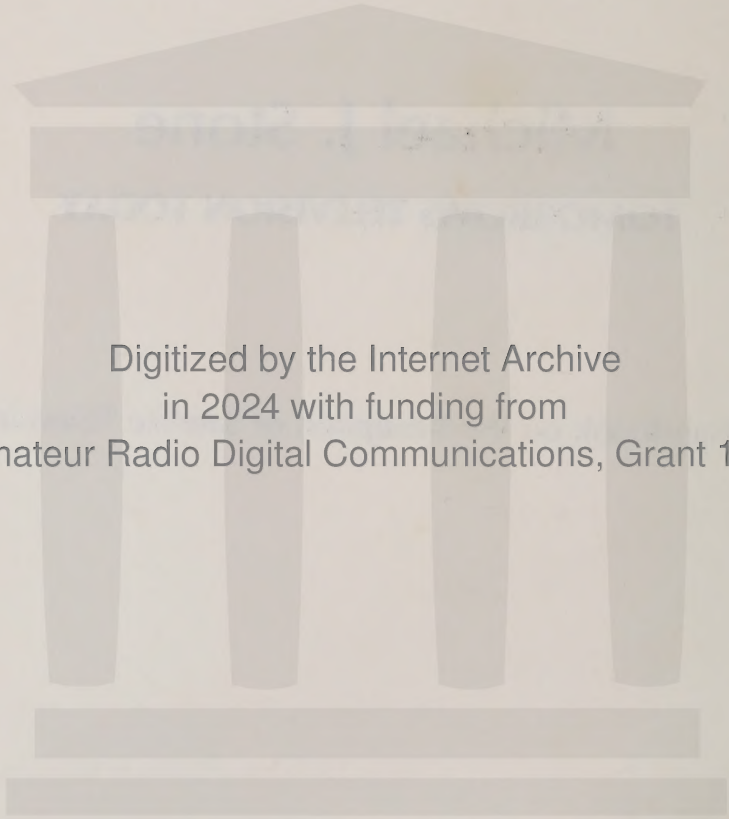

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PREFACE

It is a very short period of time since the introduction of the first operating satellite communication system in 1965. Internationally this affects most of the television viewing population of the globe. World Cup soccer and the Olympics have been broadcast live to viewers in countries around the world on many occasions.

Domestic satellites in the United States now provide television to something approaching 100,000 homes through people owning their own Television Receive Only Terminals (TVRO), and we in Europe will be offered within the next few years direct broadcast television from satellites. Much has been accomplished in the past and the future will be even more exciting now that the space shuttle is proving to be a viable alternative to the use once and throw it away rocket. Satellite communications are going to expand at an ever rapidly increasing rate.

Despite the recognised importance of satellite television a comprehensive book on this form of communication has not been available until now. This book is designed to fill the gap. The main objective is to provide a general framework on the reception of television direct from satellites.

CHAPTER 1

THE WORLD OF SATELLITES

In the October 1945 edition of Wireless World, Arthur C Clark the noted British novelist, scientist and science fiction writer published a paper explaining his theory of geosynchronous satellite orbit. He stated, that under certain conditions, the satellite could be made to orbit over the equator and travel at a speed equal to that of the earths rotation so that when viewed from a point on earth the satellite would appear to always remain in one place.

He went on to speculate that, with a minimum of three of these geo-synchronous satellites, it would be possible to provide communications for the entire world with the exception of small areas around the North and South Poles.

The precise figures involved, to obtain the geosynchronous orbit, are that the satellite must be at an altitude of 35,803 kilometers and that its rotational period would then be equal to a Sidereal day which is 23 hrs 56 mins 4.09 seconds. In the equatorial plane this satellite will then remain fixed relative to any point on earth.

In 1960 with the collaboration of Bell Telephone Laboratories, NASA and JPL, the Echo System was launched. It comprised a metalised balloon of a carefully chosen size placed in an inclined orbit at approximately 1,500 kilometers altitude. The principle that was being used was that part of the energy directed at the balloon would be redirected and picked up by receiving stations at any point of the earth from which the balloon was visible, thereby obtaining a passive satellite communication system.

In August 1960 communications were first established between Goldstone, California and Holmdel, New Jersey, the first time that a transcontinental link was established via satellite. Later the same August the first transatlantic transmissions occurred between Holmdel, New Jersey and a French receiving station. This had the effect of bringing to the world's attention that a new method of communication had arrived. Whilst the advantage of passive satellites is that they do not require any sophisticated electronics on board, they suffer from the major disadvantage of having an extremely weak signal available for reception at any place on the globe, and therefore, as soon as it was technically feasable, active satellites with sophisticated electronic transmitters and receivers on board were to be overwhelmingly chosen for most applications.

Telstar is probably the best known of these early active satellites as it was the first one capable of regularly relaying television programmes across the Atlantic. It was launched from Cape Canaveral in July 1962 and

had a power output of 2.25 watts. The total communications capability was 600 telephone channels or 1 television channel. Telstar however was still only an interim implementation of communications by satellite, since, with a maximum altitude of 5,600 kilometers it had an orbital period of 2½ hours which meant reception could only be implemented for an average of 20 mins every 2½ hours.

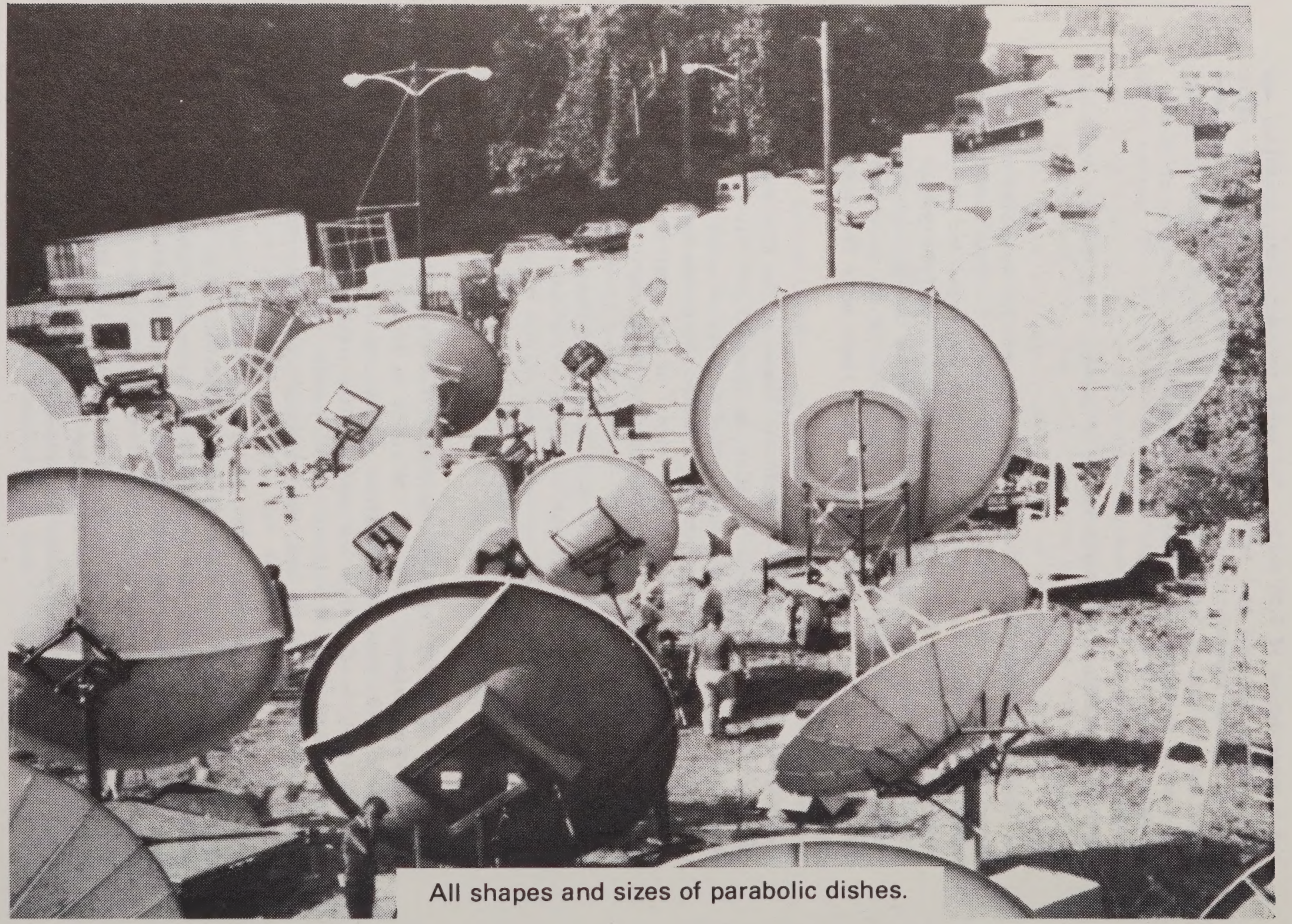
The first geosynchronous satellites to be launched were Syncom 2 and 3 in 1963/1964.

The next significant event to occur was in August 1964 when eleven nations signed an agreement to establish the International Telecommunications Satellite Consortium known as Intelsat. This was formed for the purpose of exploiting and operating a global satellite communications system. The first satellite to be launched by this consortium was Intelsat 1 (Early Bird). Launched from Cape Kennedy in April 1965 it was planned to operate for only 18 months, it actually lasted for 4 years until 1969 with 100 percent reliability.

The first mass implementation of satellite communication occurred with Intelsat IV, the first example of which was launched in 1971. Each of these are capable of providing 6,000 voice circuits or more, or 12 colour television channels,and many variations between telephone and television capacity at one time. At the present time 7 of the Intelsat IV series satellites are in orbit, either in service or on standby. Intelsat found it necessary to increase the global coverage before its next generation of satellites were ready to be launched. This caused them to upgrade the Intelsat IV series to the Intelsat IVA series which were fitted with 20 transponders, using partial frequency reuse, instead of the 12 transponders on the Intelsat IV. Five satellites of the Intelsat IVA series are in use at the present time.

The present series of Intelsat V satellites has a capability in excess of 50 standard transponder channels. It should be stressed that in the majority of cases Intelsat satellites are employed for telecommunications and data links, however they are used on quite a number of occasions to feed television around the globe. At the present time 5 Intelsat V satellites are operational with more launches planned for 1983.

The North American continent is at the present time in a very unique situation with regards to the reception of television from satellite. Due to the immense distances that television has to be distributed, satellites have proved far and away the most popular and cost effective means of obtaining this widespread distribution. It has also led to the setting up of many companies which supply, to the cable television networks, programming via the satellites and ground stations. At the present time there are a total of 10 domestic satellites viewable from the majority of



All shapes and sizes of parabolic dishes.

the North American mainland, with a further 6 scheduled for launch within the next 3 years. For an earth station owner living in the United States at the present time, there is the availabilty of 103 different channels of programming to be watched during any 24 hour period. Unfortunately at the present time none of these transmissions are receivable in the United Kingdom or Europe, but more of that later.

In order to receive signals from the earth successfully and transmit them back again, satellite have to use super high frequency radio waves operating in the radio frequency band known as Microwaves. Microwave frequencies begin at approximately 1000 megacycles (MHz) (or 1 gigacycle) and run up in frequency until they become visible lightwaves. At these frequencies radio signals take on most of the characteristics of lightwaves. They can be reflected from mirror-like surfaces and tend to travel in the line of sight only.

Communication satellites generally use microwaves operating in the frequency band of 3.5 GHz to 6 GHz known as the C Band.

Travelling the immense distances from the satellites down to the receivers on the ground, microwaves will not pass through any solid object such as the roof of a house. However, they can be picked up relatively easily by small Television Receive Only (TVRO) earth stations sitting on your lawn. The Direct Broadcast Satellites (DBS) that have been well publicised by the press lately work in the frequency range of 10.9 gigacycles to 12.5 gigacycles.

A TVRO system comprises four main units. The first is the aerial which is normally referred to as a parabolic antenna or dish. This will be familiar to most people as similar to a radar reflector seen in many applications. Fitted to the dish will be a feedhorn and Low Noise Amplifier (LNA). These units gather the signal that has been reflected and focused by the parabolic antennea, and by passing the signal through sophisticated electronic circuitry they increase the signal level significantly with very little increase in the noise level of the signal. The signal is then passed to a down converter which alters the received signal at approximately 4 gigacycles to a much lower frequency normally 70 megacycles, which allows it to be transferred into the house via normal co-axial cable. The final unit is a satellite TV receiver which takes the signal from the co-axial cable and changes the frequency modulated (FM) signal and converts it to the normal amplitude modulation (AM) that the television set is used to receiving, and it also modifies the signal to a standard that is acceptable to a normal television set.

The signal that is received by the (TVRO) at 4 gigacycles is transmitted from a ground station, up to the satellite, at a frequency of 6 giga cycles. There it is received by an antenna very similar to the normal one

used in a TVRO. It is then passed through electronics which amplify the signal and change it down to the 4 gigacycle frequency which is then retransmitted.

The main source of power for communication satellites is obtained by the use of solar cells. As a secondary system satellites are also fitted with internal batteries, normally consisting of nickel cadmium cells which enable them to operate at times when the solar cell arrays are not in direct sunlight. The satellites, whilst in a basically stable orbit, nevertheless would move very slightly and cause tracking problems for the earth reception stations if they were not ocasionally nudged back into position. Normally the satellite operators attempt to hold the satellite within a box approximately 70 miles square. In order to facilitate this, satellites are fitted with small propulsion units, and it is normally the limitation of the propulsion fuel that decides the usable life of the satellite, rather than the electronics breaking down.

Until very recently the only effective method of placing a satellite into orbit was by the one time use of an extremely expensive rocket. However, with the recent proving of the NASA Shuttle it will now allow very large and complex satellites to be placed in parking orbit, approximately 200 kilometers high, and then transfer them out to the operational geo-synchronous orbit. This will have the added advantage of being far more cost effective and also allow much heavier satellites and physically bigger units.

Currently, satellites are limited to approximately 3 metres diameter, which forces high capacity units to be long and slender. This inherently causes unstable dynamics. With the use of the shuttle the diameter can now be increased to approximtely 5 metres and allow even more sophisticated electronics to be fitted.

CHAPTER 2

SATELLITE T.V. RECEPTION IN YOUR HOME

In order for satellite television to be viewed in your home the signal has to go through four major processing sections.

Firstly, the television studio and control facilities where the television programmes originate. Then the uplink earth station which would comprise a very large parabolic antenna, typically 25 to 50 feet in diameter, and the associated transmitter. This is then received by the satellite which would convert the received signal and re-broadcast it, at a different frequency, back to the TVRO facility located at a house. A normal private earth station will feed the television picture, after processing, directly into the standard home television set.

If one wishes to do so the audio portion of the television programme can be fed through a stereo hi-fi amplifier system in order that the quality of the sound can be improved.

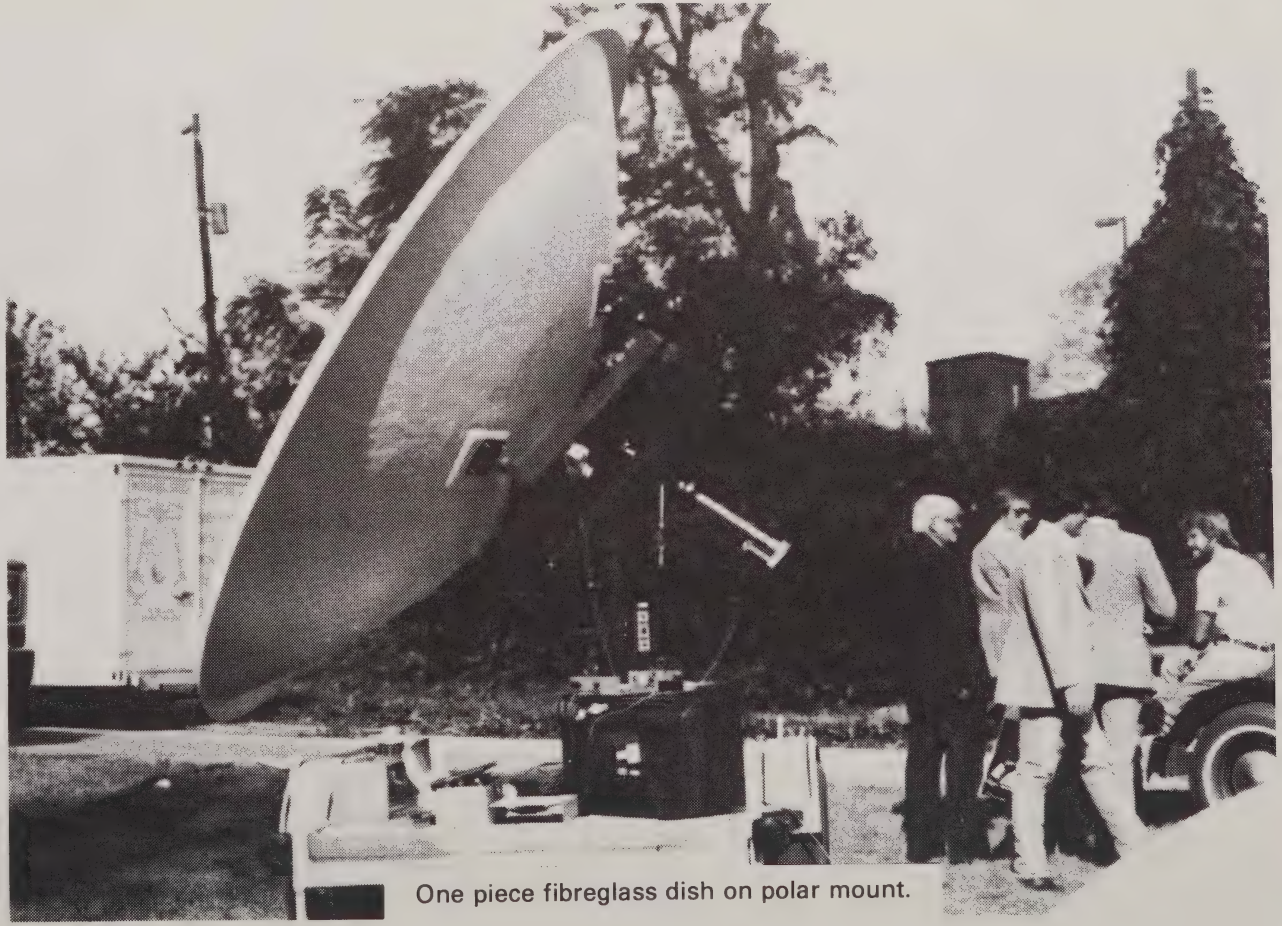
It is generally thought that the dish antenna is the satellite terminal. However this is only one component of four, although certainly it is the largest. Antennae come in two major types, firstly the parabolic dish antenna and secondly a spherical antenna, they are so named because of their rather unique shapes. The normal parabolic antenna is usually from 6 to 15 feet in diameter and would be constructed either from fibreglass, light-weight alluminium or metal frameworks covered with a wire mesh.

A parabolic antenna takes a wave received from space and focuses it to a single centre point where it is then gathered by a feedhorn.

The other popular design is the spherical antenna, which has the capability of receiving television signals from a number of satellites without having to be moved. It performs this function by focusing an arc of 4 or 5 satellites onto 4 or 5 separate focal points simultaneously. The feedhorn which collects the signal from the independent focal points is moved, rather than, in the case of the parabolic antenna, moving the whole construction.

In order to receive a usable signal it is necessary that TVRO dishes are positioned very accurately to point at the correct location in space where the satellite is orbiting. To receive the signal the dish is rotated from left to right and tilted up and down. The left to right rotation is known as the azimuth. North has an azimuth of zero (or 360) degrees, east is 90 degrees, south represents 180 degrees and west is 270 degrees. The other reference for pointing a dish is its elevation. When the dish is aimed at the horizon it has an elevation of zero degrees, when pointed directly up its elevation is said to be 90 degrees.

There are two main types of mounts for dishes, the first is referred to as the AZ/EL mount and the second is the polar mount. With each of these



One piece fibreglass dish on polar mount.

mounts, adjustment's allows for the correct positioning of the dish. At the focal point of the dish a feedhorn is positioned to collect the extremely weak signals received from space, which the dish has concentrated, reflected and focused.

There are two main types of feed. A prime focus feed in which the feedhorn is positioned directly at the focal point in front of the dish. The second is the cassegrain feed in which the signal is reflected, a second time at the focal point, back in towards the dish via the feedhorn and into the LNA located at the rear of the dish.

Connected to the end of the feedhorn is the LNA. This is constructed by using extremely high frequency transistor circuits which are capable of amplifying the very weak signal from space without mixing them with a large amount of noise produced by the amplifier itself. The signal received at the LNA is generally less than one millionth as strong as a normal television broadcasting station's signal and therefore, substantial preamplification is necessary. At these low signal levels even the background noise produced by the earth radiating its heat can interfere with the minute signals received. This is the reason that LNA's are normally rated in terms of degrees kelvin of noise figure. That is, the amount of noise that the LNA generates compared with that of a device operating at zero degrees kelvin (minus 273 degrees C).

The output signal from the LNA, now amplified, is fed either directly or via low loss co-axial cable into the down converter. The down converter serves the function of bringing the four gigacycle received signal from the satellite down to the level, normally of 70 megacycles, which makes the signal much easier to handle. It also has the advantage that components used to make it suitable for displaying on a normal television can be obtained very cheaply, as they are normally used in standary television receivers and associated, everyday, electronic equipment.

The satellite receiver takes in the intermediate frequency (IF) 70 MHz television signal and converts it to standard base band video and audio signals which generally appear on two output sockets at the rear of the receiver. Base band video signal cannot be fed directly into a standard television. It is similar to the signal that comes from a television camera. In order to display the video on the television set the signal has to be fed into a radio frequency (RF) modulator which converts it into a normal UHF television frequency that can be tuned in on the set on any spare channel.

As previously mentioned there are two main frequencies upon which television is transmitted, these being the twelve gigacycle band which has been allocated for Direct Broadcast Service (DBS) which will come into operation in Europe within the next two to four years, and the 4 GHz band. At the present time there are some experimental broadcasts taking place on the 12 GHz band but they are generally not available for reception. A

further point to be taken with regards to twelve gigacycle transmission is that the technology for reception at this super high frequency is not generally available for the average persons to obtain. Luckily however, there is a considerable amount of activity on the other, four gigacycle, band used for television transmission and, due to the vast amount of work and capital invested in reception at this frequency in the United States, the technology to implement watching television in your home, received on this frequency, is readily available at a not unreasonable cost.

At the present time there are a total of twenty six satellites which broadcast in the four gigacycle band in view from most of Europe. Of these twenty six satellites eleven broadcast television for at least part of the day, every day. However, it must be stated that to receive some of these transmissions is extremely difficult, if not impossible. Scheduled for launching by the end of 1985 are a further fourteen satellites which will transmit on the four gigacycle band, and it is certain that a number of these will also be used for the transmission of television.

At the time that the engineers design the broadcast systems for the satellite they take the opportunity of shaping the beam on the transponders so that the signal broadcast to earth can be centred upon a chosen point. The further one is away from the central area chosen to receive the maximum signal the more the perceived power of the signal reduces. A map can be drawn of the signal strength received from any single transponder, and this is generally referred to as the footprint. Different satellite transponders on the same satellite will often have different footprints of signal strength.

On the more modern satellites now being orbited, Engineers have also developed the technique of frequency reuse. This is obtained on twenty-four transponder satellites by using vertical and horizontal polarization of the signals, so as to reuse the same frequency on the same satellite. This allow's twenty four separate signals to be squeezed into the same frequency spectrum which would normally be capable of carrying only twelve signals. The method of vertical and horizontal polarization is favoured mainly by the American domestic satellites. On the Soviet and Intelsat systems the same frequency reuse is obtained by the method of right-hand and left-hand circular polarization. That is, the signal is transmitted to earth in a spiral form, whereby the electromagnetic field vectors are rotated 90 degrees about the axis of propagation, each time a quarter wavelength distance is travelled. The rotation can either be clockwise or anticlockwise, hence, the two methods of circular polarization. For simplicity's sake the signals can be likened to a corkscrew.

In both cases, of either linear or circular polarization, the difference is sufficient that receivers are only capable of tuning either of the perceived transmission, dependent upon how they are set up, at any one time, and no interference is received from the opposite channel on the same frequency.

CHAPTER 3

ANTENNA AND MOUNTS FOR T.V.R.O.

The parabolic dish is the most popular and efficient type of antenna for use with a TVRO terminal. The majority of systems in use employ this type of antenna in preference to the alternatives. Large horns, stacked yagis or colinear arrays, either are physically too large or do not supply sufficient gain to be of any serious use at the frequencies used.

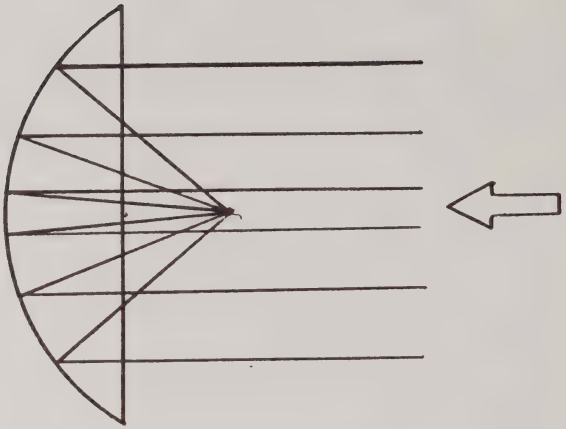
The eliptical or spherical reflector is the only other practical alternative to a parabolic dish, which is worth considering. The main difference between a parabolic dish and a spherical reflector is the method by which the signal is collected. In the case of a parabolic antenna the reflective surface has the configuration of a parabolic curve. When this surface is precisely aimed at a signal source the energy striking that surface will be reflected to a single point known as the focus. This focus is where the feedhorn would be mounted to obtain the maximum efficiency in the system. The focal point of a parabolic dish will never change. The entire reflective surface is rotated in order to track the various satellites. The main advantage of a parabolic dish is that it always offers the entire surface towards the incoming signal.

The other alternative, the spherical reflector, reflects the incoming signal to a focal point, which is not always in line with the signal source. This offers the situation whereby the spherical reflector is secured in a fixed position, and the feedhorn is moved in front of it to the appropriate focal point for the satellite that is wished to be viewed. However, the further off-centre one mounts the feedhorn, the less signal is perceived from the reflector, since, as the angle between the incoming signal and the feedhorn increase, the aperture will simultaneously decrease.

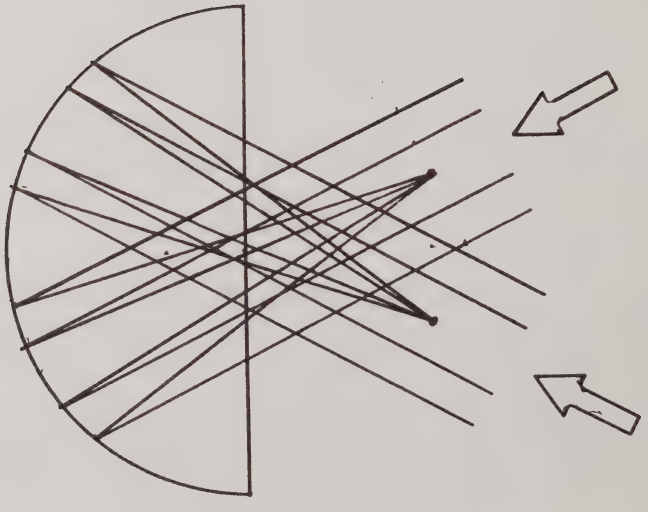
In this chapter we will concentrate upon the design and usage of the parabolic antenna, since it offers the greatest advantages and the highest gain, relative to size, obtainable.

Measurement in Decibels

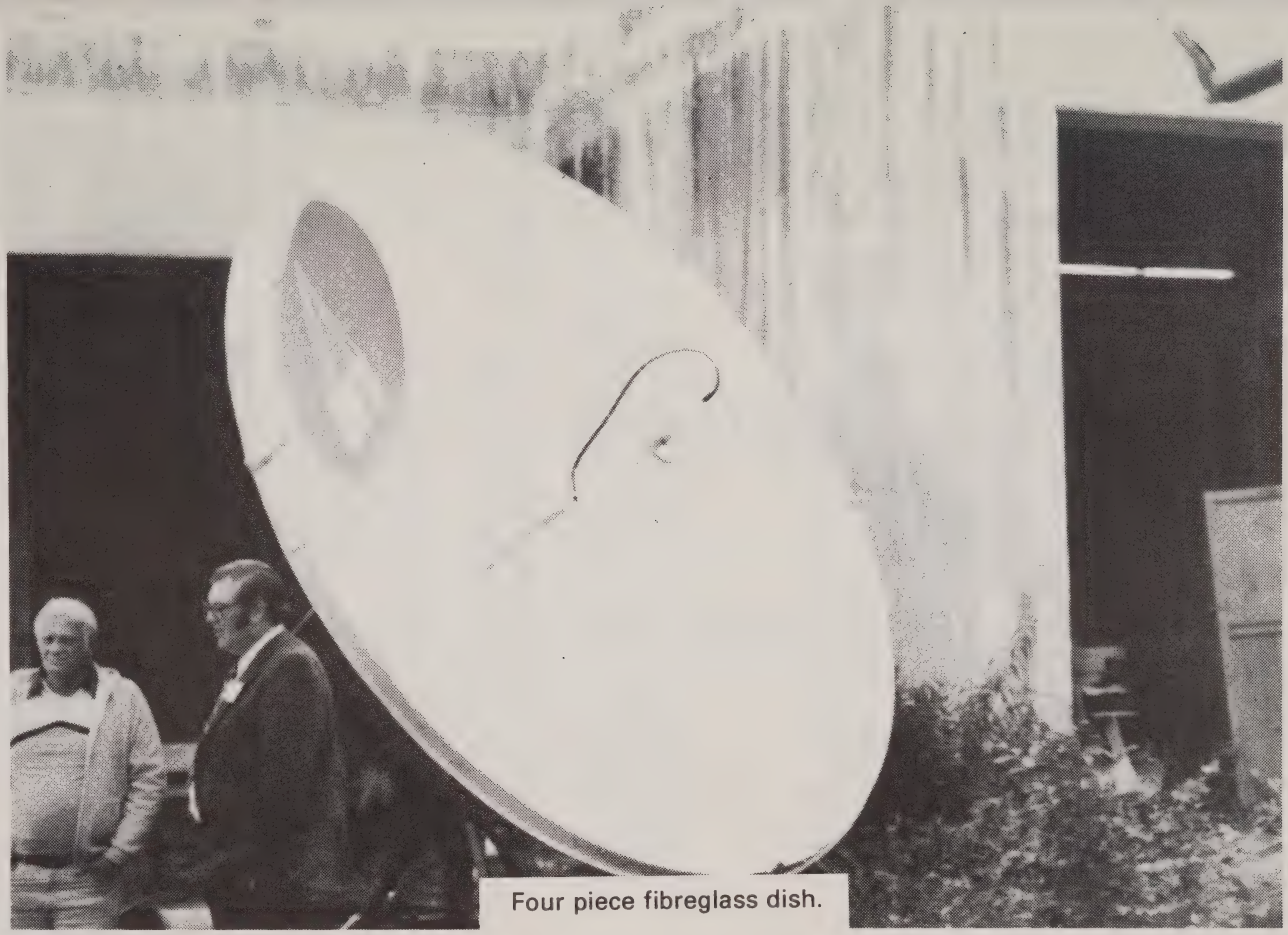
The first item to be mastered is the term decibel. The majority of the calculations used in satellite television, such as antenna gain, LNA gain and carrier to noise ratio, are expressed in decibels (dB), and it is important to understand this term. All items which relate to power such as watts, E.I.R.P., signal gain, antenna gain, LNA gain, coaxial cable loss and all types of attenuation, use the definition of a decibel as, a unit for expressing the ratio of two amounts of electric signal power equal to ten times the common logorithm of this ratio.



Parabolic antenna (single focal point)



Spherical antenna (multiple focal points)



Four piece fibreglass dish.

This definition is probably very confusing, so it can be broken down as follows.

The first point to understand is that the dB can be a ratio with no quantitive value implied, next, that a dB is an expression of a ratio. A ratio compares two numbers and is often written as a pair of numbers separated by a colon. For example the numbers 100 and 10 have a relationship that can be expressed as 10 : 1. Because a dB is a ratio, it is possible to look at the figure and imagine what has happened to the value. It is easy to become proficient at interpreting the amount of gain or loss that has occurred mentally, converting the dB to a multiplier or a divider. The following chart gives the ratios of various dB watts values turned into multipliers, and is indicative of the ratio of a signal output from a device relative to the input.

dB Watts		Multiplier Ratio
0 dB	=	Times 1
3 dB	=	Times 2
6 dB	=	Times 4
9 dB	=	Times 8
10 dB	=	Times 10
20 dB	=	Times 100
30 dB	=	Times 1000
40 dB	=	Times 10,000
50 dB	=	Times 100,000
60 dB	=	Times 1,000,000

As an example of how to change watts ratio into dB we will take the example of an amplifier that would have increased a signal level 100 times. This would be expressed firstly in the ratio of 100 : 1.

dB = 10 Log Power Ratio
= 10 Log 100
= 10 x 2
= 20 dB

In order to do the opposite and convert dB watts to a multiplier ratio you would do the following taking 40 dB as the example.

Muliplier Ratio = Antilog (40 ÷ 10)
= Antilog 4
= 10,000

The above chart will show that the signal level is doubled for every increase in level of only 3 dB.

It should now be possible for you to change from dB to a real number ratio or from a real number ratio to dB. Also, by reference to the chart, it should be easy to estimate how much gain or loss dB represents.

We will now show by reference to the real world, some of the ways in which dB's are used, so that their meaning can be interpreted.

Remember that a dB is always a ratio, and that it can be a ratio which is related to a 0 dB standard, or a ratio of one term of value compared to another, without reference to a 0 dB standard.

As a example, an antenna which would have a stated gain of 39 dB compared to a second unit with a gain of 36 dB, would have a 3 dB advantage. This would indicate that the first antenna would have twice the gain of the second. As a second example, if one was to take a low noise amplifier with a 50 dB gain and a noise factor of 1 dB, this can be quantified as the amplification of the received signal being 100,000 times, and the increase in noise being 1.259 times.

Antenna Gain

We are now in a position to calculate the gain of an antenna, from knowing the area of its aperture and the wavelength it is intended to use it on. We will use as an example, a 10ft diameter dish at a frequency of 3.95 GHz. Since the effective area is the area of the circle described by the perimeter of the antenna, we can calculate the area using the formula

$$A = Pi\ R^2$$
$$= Pi \times 25$$
$$= 78.5 \text{ sq. ft.}$$

Where A = Area of Aperture
R = Radius of Aperture
Pi = 3.1452

thus the aperture area of a 10ft diameter dish is 78.5 sq.ft.

The formula for calculating the antenna's wavelength is

$$W = \frac{984}{F}$$

Where W = Wavelength in Feet
F = Frequency in MHz

The frequencies at which satellite's transmit extend from 3.7 GHz to 4.2 GHz. GHz are converted to MHz by multiplying by one thousand. In the example we will use the mid point of the transmission band which is 3.95 GHz, therefore

$$W = \frac{984}{3950}$$

$$= .25 \text{ feet}$$

Having quantified the two variables needed to calculate the gain we can proceed as follows

$$G = 10 \text{ Log } \frac{4 \text{ Pi } (A)}{W^2} \times E$$

$$= 10 \text{ Log } \frac{4 \text{ Pi } 78.5}{W^2} \times \frac{55}{100}$$

$$= 10 \text{ Log } \frac{4 \times 3.142 \times 78.5}{.0625} \times .55$$

$$= 10 \text{ Log } (8681)$$

$$= 10 \times 3.94$$

$$= 39.4 \text{ dB}$$

Where G = Gain in dB
A = Area of Aperture
W = Wavelength
E = Percentage of Efficiency

In the above example the efficiency of the antenna and feed has been assumed at 55%.

f/D Ratio of an Antenna

The next item to consider is the f/D ratio of a parabolic antenna. This is expressed as the product of the distance from the focus to the origin of the dish, divided by the diameter of the dish. Therefore a 10 ft. dish with the focal point 4 ft. above the base of the dish has a f/D ratio of .4. Dishes with a very low f/D ratio require special feeds that make them difficult to build, and feeds with very large f/D ratios suffer from ground noise problems. Therefore, it is normal practice to have dishes with f/D ratios between .3 and .5. This range is a compromise between the good side lobe rejection of a deep antenna, and the high gain that can be obtained from a shallow antenna.

In the situation where the focal length of a dish is unknown, this can be calculated from knowing the diameter of the dish and the depth of the parabola in the centre. The formular for doing this is

$$F = \frac{D^2}{16C}$$

F = Focal length
D = Diameter of dish
C = Depth of parabola in centre

As an example if a dish has a diameter of 120" and the depth of the parabola at the centre is 16.6" the calculations would be as follows

$$F = \frac{D^2}{16C}$$

$$F = \frac{120^2}{16 \times 16.67}$$

$$F = \frac{14400}{265.6}$$

$$= 54.21 \text{ inches}$$

Antenna Accuracy and Design

When designing a parabolic antenna it is important to realise how accuracy will effect the final efficiency of the dish. The accuracy is determined by how closely the dish follows the parabolic form. Over a small area, deviations as large as 1/2 to 3/8th of an inch will not effect the gain very much, therefore, screwheads, boltheads, rivets and small joining strips effect the gain very little. However, if the deviations occur over a large area of the dish, as little as 1/8th of an inch distortion can reduce the gain by as much as one decibel. For example if an area of the dish 4" long x 4" wide was 3/8th of an inch out of tolerance the loss resulting would approach 6 dB in which case the dish could be replaced by an accurate unit of half the diameter without loss in gain.

In order to design a parabolic dish it is necessary to calculate the constant points to determine the parabolic curve. The factors that make up the constants in this equation are functions of the focal length and the diameter of the dish desired. If the diameter and focal length are known, you have all the information necessary for using the formula.

$$X = \frac{Y^2}{4D\ (f/D)}$$

Where D = Diameter of dish
f/D = Focal length diameter

As an example, to construct the profile of a dish 72" in diameter having an f/D ratio of 0.3, the procedure is as follows

$$X = \frac{Y^2}{4D\ (f/D)}$$

$$X = \frac{Y^2}{4 \times 72 \times 0.3}$$

$$X = \frac{Y^2}{86.4}$$

$$X = 0.01157\ Y^2$$

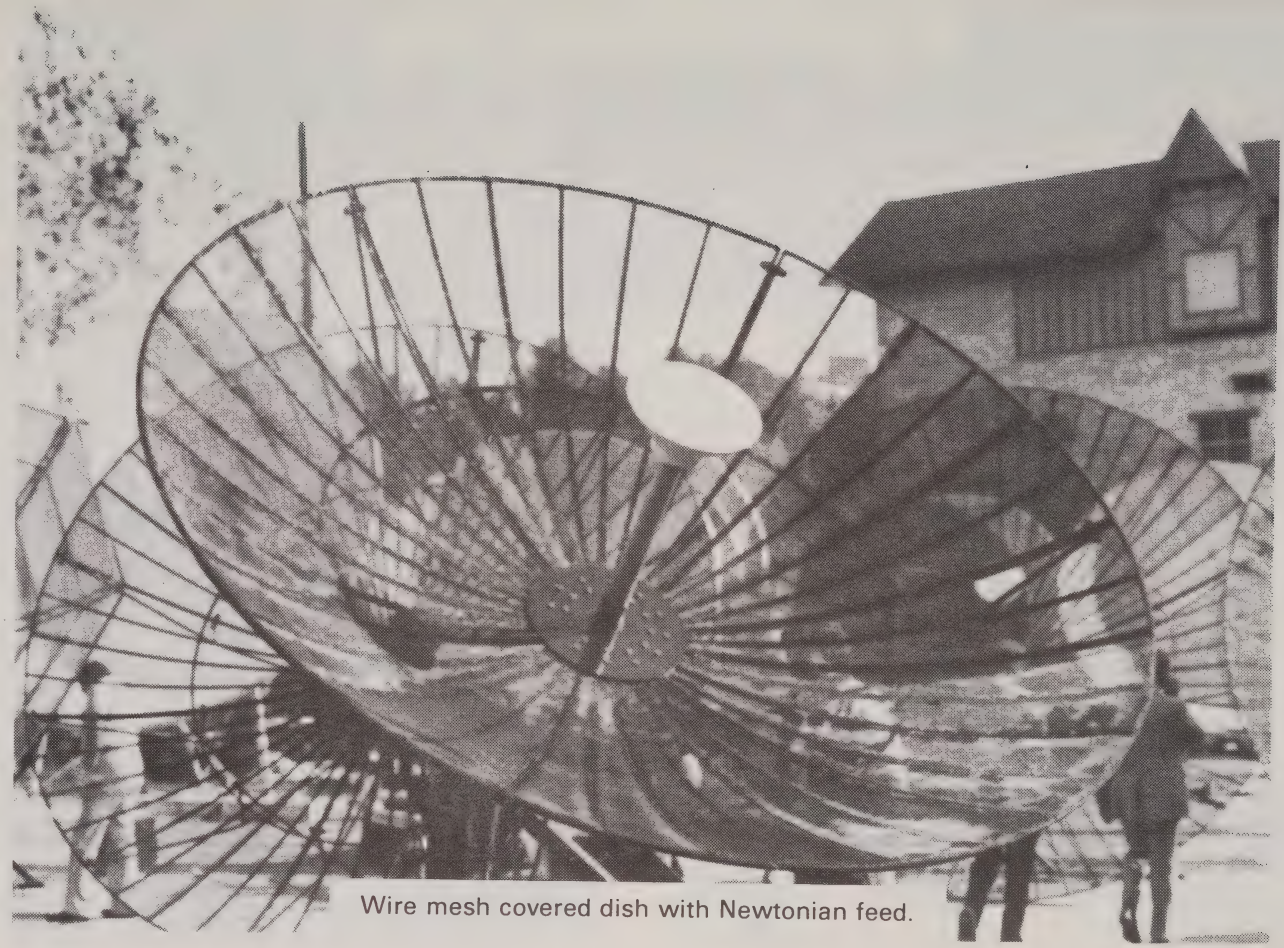
Using the above calculations, a list can be drawn up for as many points as are required in the form of

$\pm$ Y(in)	Y^2	$0.01157Y^2$ = x (in)
0	0	0
4	16	0.18
8	64	0.74
12	144	1.67
16	256	2.96
20	400	4.63
24	576	6.66
28	784	9.07
32	1024	11.85
36	1296	14.99

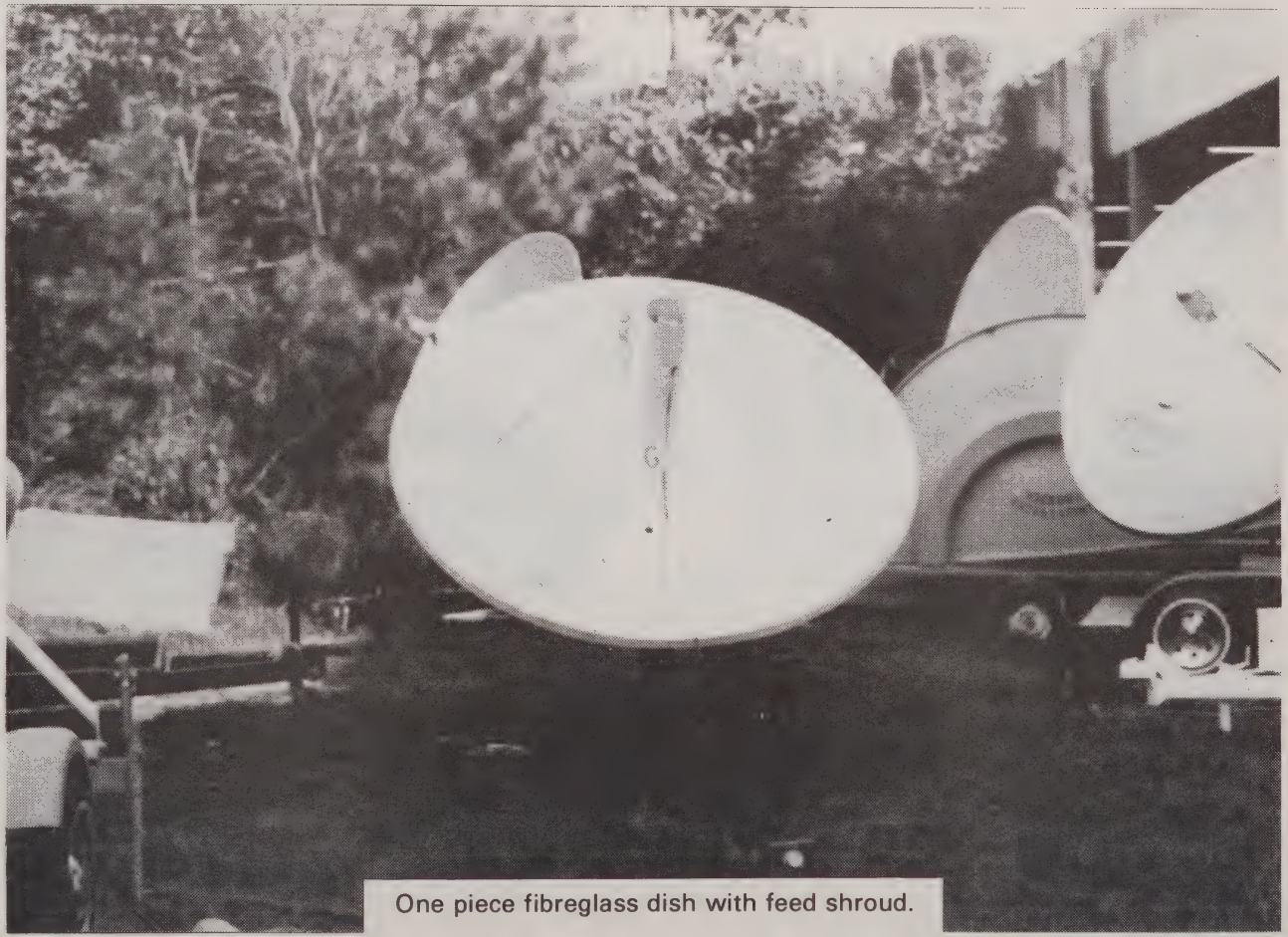
If Y is now plotted from +36" to -36" versus the value of X it will give the required parabolic curve.

In reality, to obtain a sufficiently accurate dish the above calculations should be carried out at 1" points.

There are many different methods available for the construction of parabolic dishes. Aluminium or steel, spun, metal dishes are the type generally used in commercial applications. Another alternative for a solid metal dish is to construct it from multisections of aluminium or steel petals which are fixed to a rigid framework. These petals are either



Wire mesh covered dish with Newtonian feed.



One piece fibreglass dish with feed shroud.

stamped out or formed around the ribs of the framework. A large number of dishes are also manufactured from glass fibre, either in one piece or in a number of sections. In glass fibre construction it is necessary to lay into the main section, either a thin metal insert or wire mesh. Another popular type of dish is one where wire mesh is laid over the radial ribs, this has the added advantage that the dish has a much lower windage than one of a solid construction.

Broadly speaking, providing that the maximum dimension of the hole in the wire mesh is less than about ½" then the loss in gain will be less than 1 decibel when compared to a solid dish. The most suitable materials for the wire mesh are copper, aluminium or galvanized iron. Plain iron or alloys such as brass will be more lossy.

Beamwidth and Noise

Another factor to be considered when viewing the design of a parabolic antenna is the beamwidth of the dish in question. Beamwidth can be calculated from the formula

$$\text{Beamwidth} = \frac{4 \times \text{Wavelength (GHz)}}{\text{Diameter of dish (FT)}}$$

An antenna with a narrower beamwidth will focus on a smaller area of the sky. Since noise is one of the main problems of satellite television reception and the atmosphere is a noise generator, a narrower beamwidth will pick up less noise than a wider one. The following chart shows gain, beam-width and approximate noise temperatures for various antennae at a 35 degree elevation.

Ant Dia (FT)	Gain (dB)	Beamwidth (Deg)	Noise (Deg K)
8	38	2.0	40
10	39.5	1.6	30
12	41	1.3	24
15	43	1.1	20

The above demonstrates that as the size of the antenna increases, its beamwidth and noise decrease, and the gain increases.

As the elevation of an antenna is reduced much below 10 degrees, it will start to pick up earth noise which is generated by any living organism because of the molecular motion of the living cells. The earth's surface and trees live, breath and create noise. Generally speaking earth noise is accepted as being the temperature of 290°K. As can be appreciated, any antenna pointed directly at the earth will be giving a very noisy signal.

When working with a dish which is set at a very low angle of elevation, an allowance must be made for the increase in earth noise.

There is a possibility of partially limiting the earth noise at very low angles by fitting, around the periphery of the dish, a shroud. This would also have the added advantage of reducing the pick-up for any unwanted terestrial signals that may be in your area.

Earth noise is yet another item, which has to be taken into account when calculating the efficiency of a satellite receiver set-up.

Mounts for Antenna's

An important consideration that will have a bearing on the type of antenna chosen will be that of the mount.

The two major types of mount are the AZ-EL and the polar mount.

With the AZ-EL type of mount, two movements are required to change from one satellite to another, these being rotation (azimuth) and elevation. One advantage of this type of mount is that it is capable of tracking satellites outside of those in geostationery orbit.

The alternative, the polar mount is undoubtedly the most practical and the most convenient for viewing satellites in geostationery orbit. When correctly set up, an antenna on this mount will track all the satellites in geostationery orbit accurately and easily by only rotating the antenna.

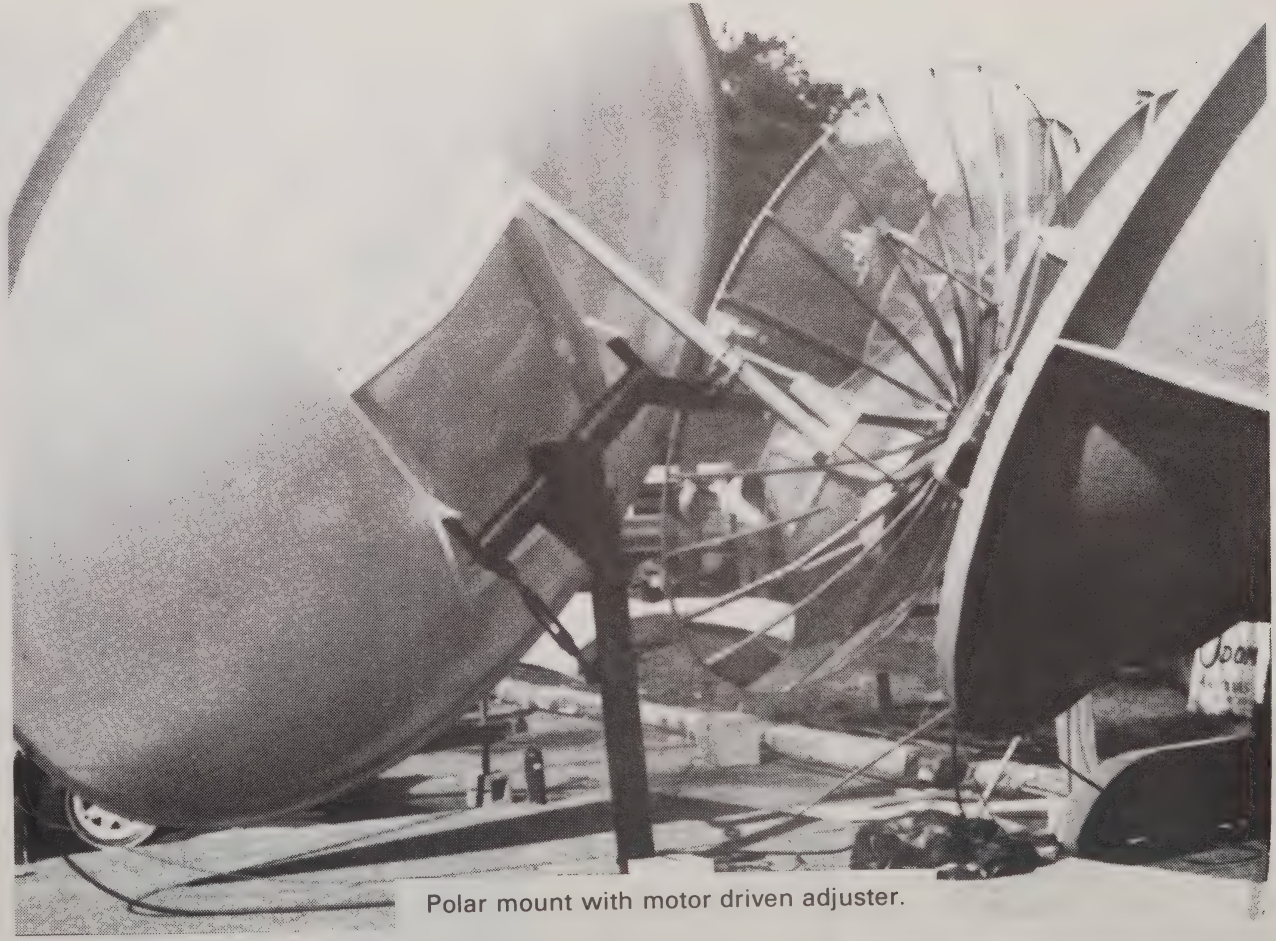
A polar mount is set up by taking a line formed by the upper and lower edges of the reflector. This line must be adjusted to point exactly at the north star, it should form an angle with the ground, equal to the latitude of the site.

This adjustment can be made by using an inclinometer.

It is then necessary to make a final adjustment to enable the polar mount to track the geostationery satellites accurately, whilst rotating the antenna in only one plane. This offset angle which is approximately 7 degrees in the United Kingdom, is obtained by moving the dish away from its top point of mounting, whilst pivotting it on the bottom point.

It is best to check the reception from a number of satellites to make sure that the antenna is tracking properly, before the foundations of the main mount are irrevocably cast.

Dish mounting assembly on polar mount *Note* Inclinometer.



Polar mount with motor driven adjuster.

It cannot be stressed to strongly that whatever form of mount is used its construction is sufficiently strong enough to withstand windforces that may come to bear upon it.

To give an example, a 10 foot diameter dish with a solid reflector which is subject to a windspeed of 50 miles per hour, a not uncommon value, will be subjected to a pressure of about 9 lbs per sq. ft., therefore the whole structure would suffer a windforce in the region of 700 lbs, on top of which an engineering safety factor should be applied.

The usage of a wire mesh dish will show considerably less windloading in the circumstancies as described above.

Aiming the Antenna at Satellites

As previously stated, in order to receive the signal being broadcast from the satellite, the antenna needs to be very precisely aimed at the point in space occupied by the satellite.
It would seem that calculating the necessary coordinates would be a highly complex task, but with the proliferation of inexpensive scientific calculators and small home computers it is a relatively simple procedure.

In order to use the following formula it is necessary to know three varying factors. These being the latitude and longitude of the site at which the antenna is being used, and also the position in degrees in geostationery orbit that the satellite is occupying.

The following is the formula for calculating the azimuth of the satellite.

Azimuth (AZ) = 180° + Arctan (Tan B/Sin A)

Where A = Latitude of earth station
B = Longitude of earth station (East is +, West is -) minus the longitude of the satellite.

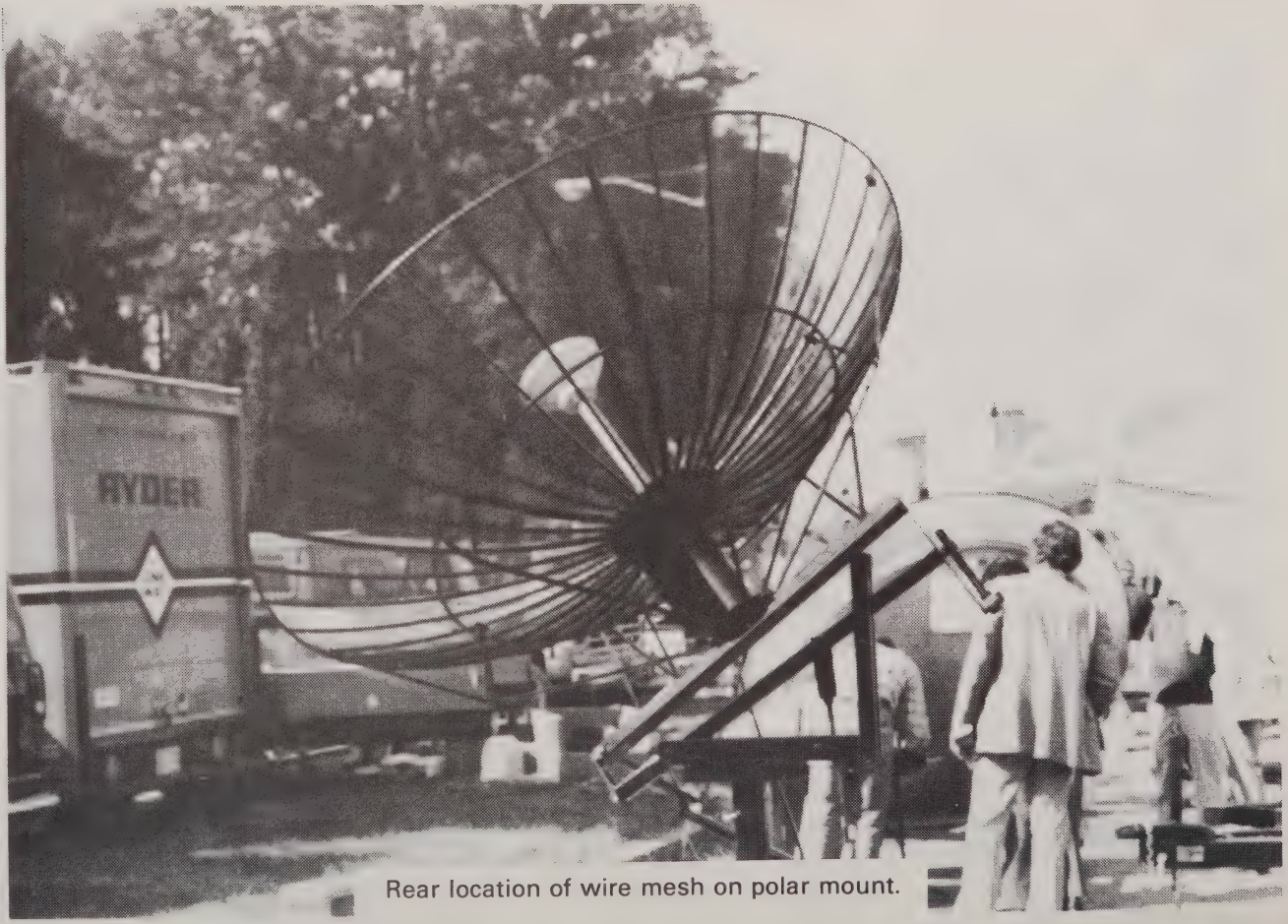
In order to calculate the distance between the ground station and the satellite the following formula is used.

Distance = H x Square root of [1+0.41999 x (1-Cos X)]

Where H = 22245 miles
X = Arcos (Cos B x Cos A)

The final formula, to calculate the elevation angle is as follows.

Elevation = Arctan [(Cos X -0.151269)/Sin X]



Rear location of wire mesh on polar mount.

As an example, if we take a ground station based in Bristol, which has a longitude of 2.5 degrees west and a latitude of 51.5 degrees, and we want to align the antenna with the Intelsat Major Part 1 satellite at 34.5 degrees west the calculations would be as follows.

Azimuth (AZ) = 180 + Arctan (Tan 32/Sin 51.5)
= 180 + Arctan (0.6249/0.7826)
= 180 + Arctan (0.7984)
= 218.6 (Degrees)

If the distance of the earth is 3,957 miles and the height of the satellite is 22,245 miles then

Distance = 22245 x Square root of [1 +0.41999 x (1 - Cos x)]
= 22245 x Square root of [1 +0.41999 x (1 - 0.5729)]
= 22245 x Square root of (1.1983)

= 24350 miles

and to calculate the elevation angle

Elevation = Arctan [(Cos 58.1348 -0.151269)/Sin 58.1348]
= Arctan 0.4435
= 23.9 Degrees

CHAPTER 4

FEEDS, HORNS AND WAVE GUIDES

Designing Feeds for Dishes

(a) In a perfect feed system for a parabolic dish, all the energy would appear to be concentrated at a point source placed at the focus of the dish. This energy would be obtained from a cone shape which would just intercept the edge of the dish. All this energy would have been reflected and focused by the dish from the incoming signal. Unfortunately there are a number of problems in getting a perfect level of illumination. Normally, the maximum signal is received at the axis of the feed and then falls off on either side, due to the fact that it is impossible to design a feed having a sharp cut-off. No precise value can be specified as the beamwidth of a feed, and all that can be specified is the point at which the power density relative to the beamwidth has fallen by a percentage of the value. For instance, one would state that a horn would be 10 dB down at the edge of the dish.

If the beamwidth of a feed is too high, the feed would be looking around the edge of the dish and, therefore, receiving background earth noise. If the beamwidth was too low it would not be obtaining as much of the signal energy as was theoretically available, therefore a judgement has to be made with regards to the correct beamwidth of a feed for any dish.

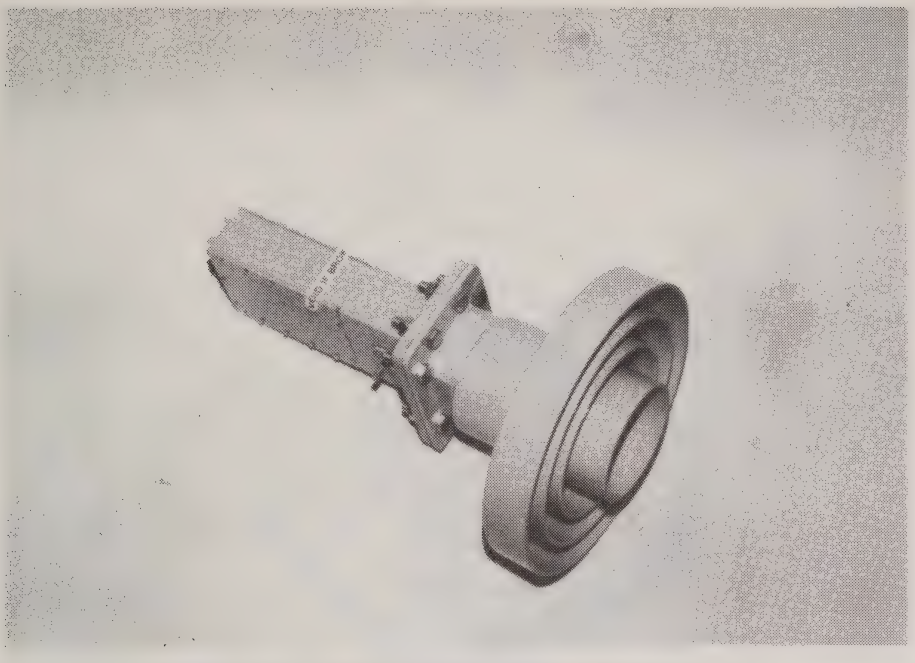
(b) Due to the fact that the rim of a parabolic dish is further from the feed than is the centre of the dish, there is some loss already built into the system. This loss is referred to as the space loss and will vary according to the f/D ratio of the dish in question. As the focal length on a dish increases the space loss becomes smaller.

(c) In order to obtain high efficiency, the dish must be viewed as evenly as possible over its whole surface, and certain designs of feedhorns are better at doing this than others.

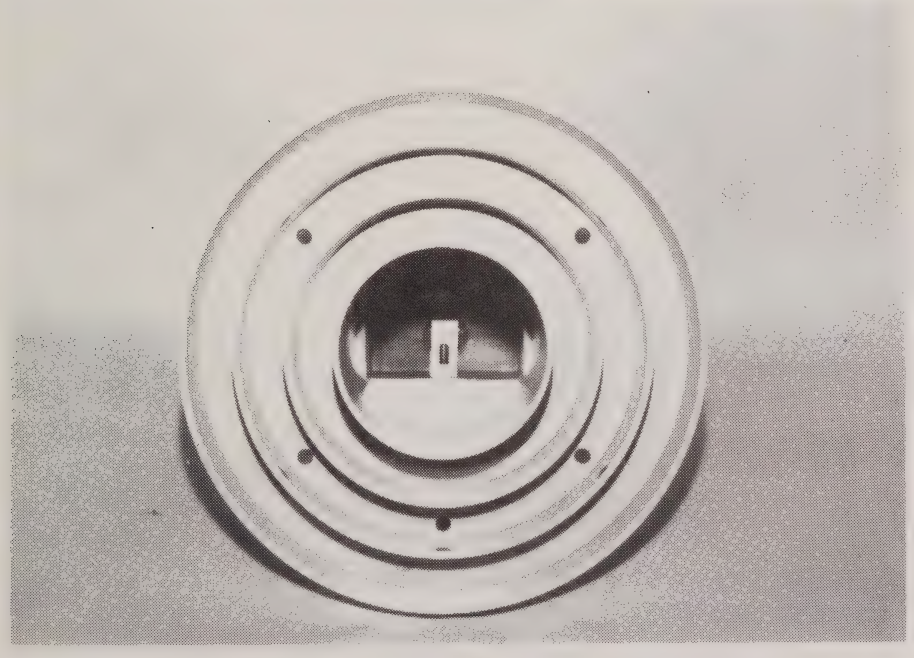
Types of Feedhorns

There are a large number of designs available for feedhorns, but from a practical point of view all of these can be discarded, with the exception of the Scalar horn.

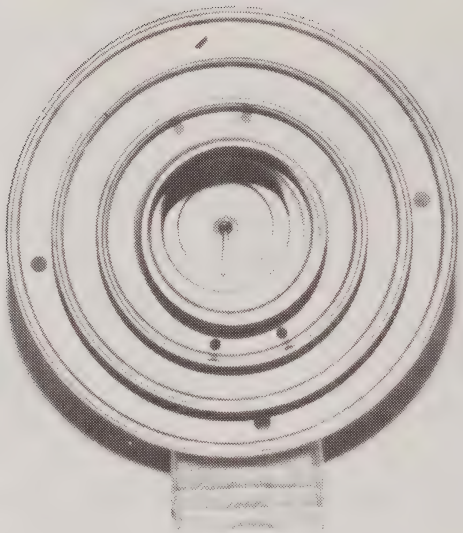
This is due to the fact that it is the only practical design capable of resolving the four principal senses of orientation of signals. Those being vertical, horizontal, right-hand circular and left-hand circular.



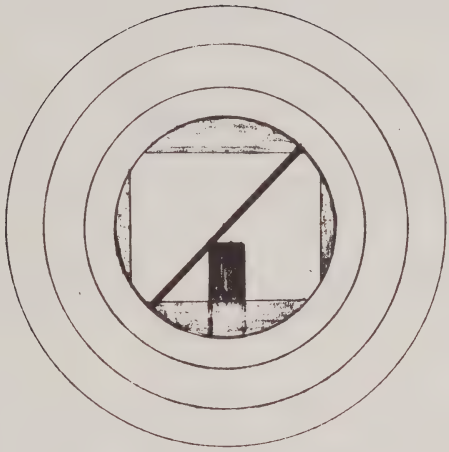
Scalar horn feed mounted to low noise amplifier.



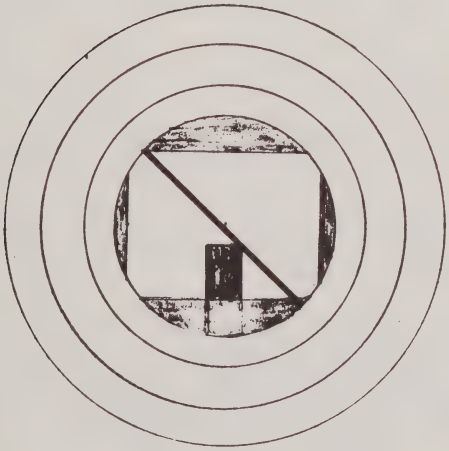
Front view of scalar horn feed with probe visible in background.



Front view of Scalar Horn Feed with adjustable polarization. Probe in centre of horn set for vertical reception. If probe is rotated 90° it is then set for horizontal reception. Microwave substrate inserted at 45° to the probe (clockwise, 10 minutes past 8 position) will allow right hand circular signals to be resolved. The substrate, if placed 45° in the opposite direction (anticlockwise, 10 minutes to 4 position), will resolve left hand circular signals.



Microwave substrate inserted into Scalar Feed Horn for R.H.C.P.



Microwave substrate inserted into Scalar Feed Horn for L.H.C.P.

If reception of a circularly polarised signal is attempted by a feedhorn designed for vertical and horizontal polarisation, a loss of 3 dB will occur. This would effectively mean, that if the dish you were using was 10 ft in diameter, that it would in fact only be working as efficiently as a 6 ft dish.

Scalar horn feeds are available in two main types.

The first is a straightforward feedhorn which bolts directly onto the LNA, and the assembly of these two units would have to be rotated through 90° in order to differentiate between vertical and horizontal polarisation.

The second version incorporates a moveable probe within the feedhorn which can in fact be moved over considerably more than 90°, and the effect of rotating the probe within the feedhorn is exactly the same as rotating the complete assembly.

Scalar horns are normally supplied suitable for usage with horizontal and vertical polarisation only. However, it is an extremely simple task to convert them to receive circular polarisation. This is effected by inserting in the centre of the Scalar horn a small length (3") of microstrip substrate (dielectric constant approximately 10). This insert being fitted at an angle of 45° to the probe in the LNA will, dependent upon its orientation to the probe, (left-hand or right-hand) resolve circularly polarised signals with minimal loss.

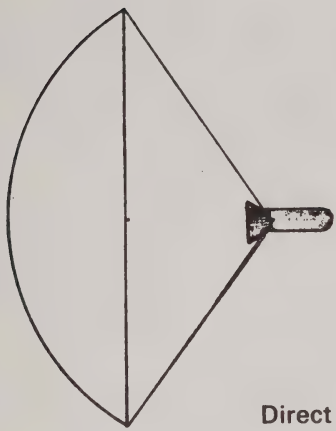
Generally speaking, the use of a Scalar horn will give an increase of 0.5 dB on a parabolic dish. In some instances the increase in gain can be as much as 1.5 dB.

Practical Feed Systems

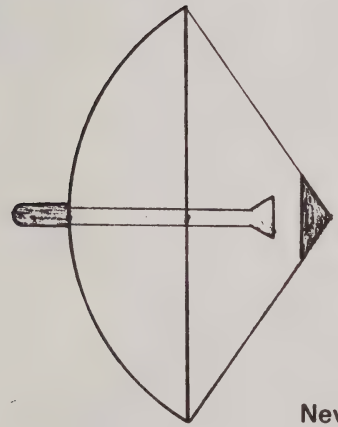
There are two methods of mounting feeds on dishes, these are the direct and the indirect methods.

In the direct method the centre of the feed is placed precisely at the focus of the dish. The signal reflected from the dish will go immediately into the feed and on to the LNA.

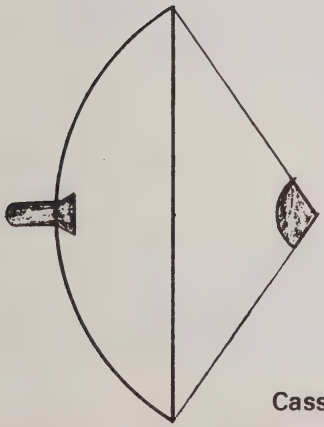
The main advantage of a direct feed is that it is relatively easy to construct, and has a high overall efficiency. It also leaves the back of the dish clear, which can make mounting much easier. Its main disadvantage is that the support structures do need to be fairly strong in order to accurately support the weight of the feedhorn and LNA.



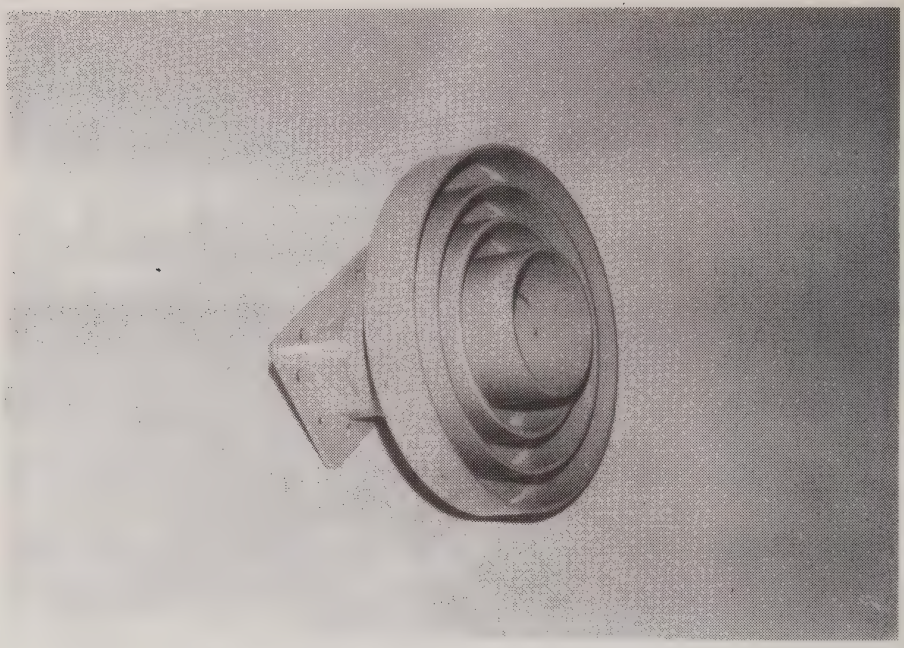
Direct Feed



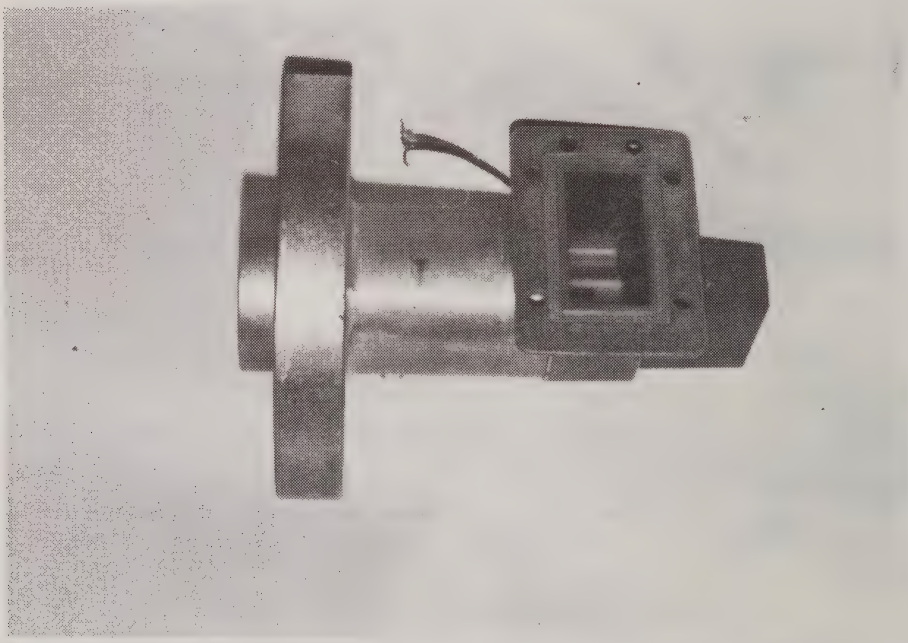
Newtonian Feed



Cassegrain Feed

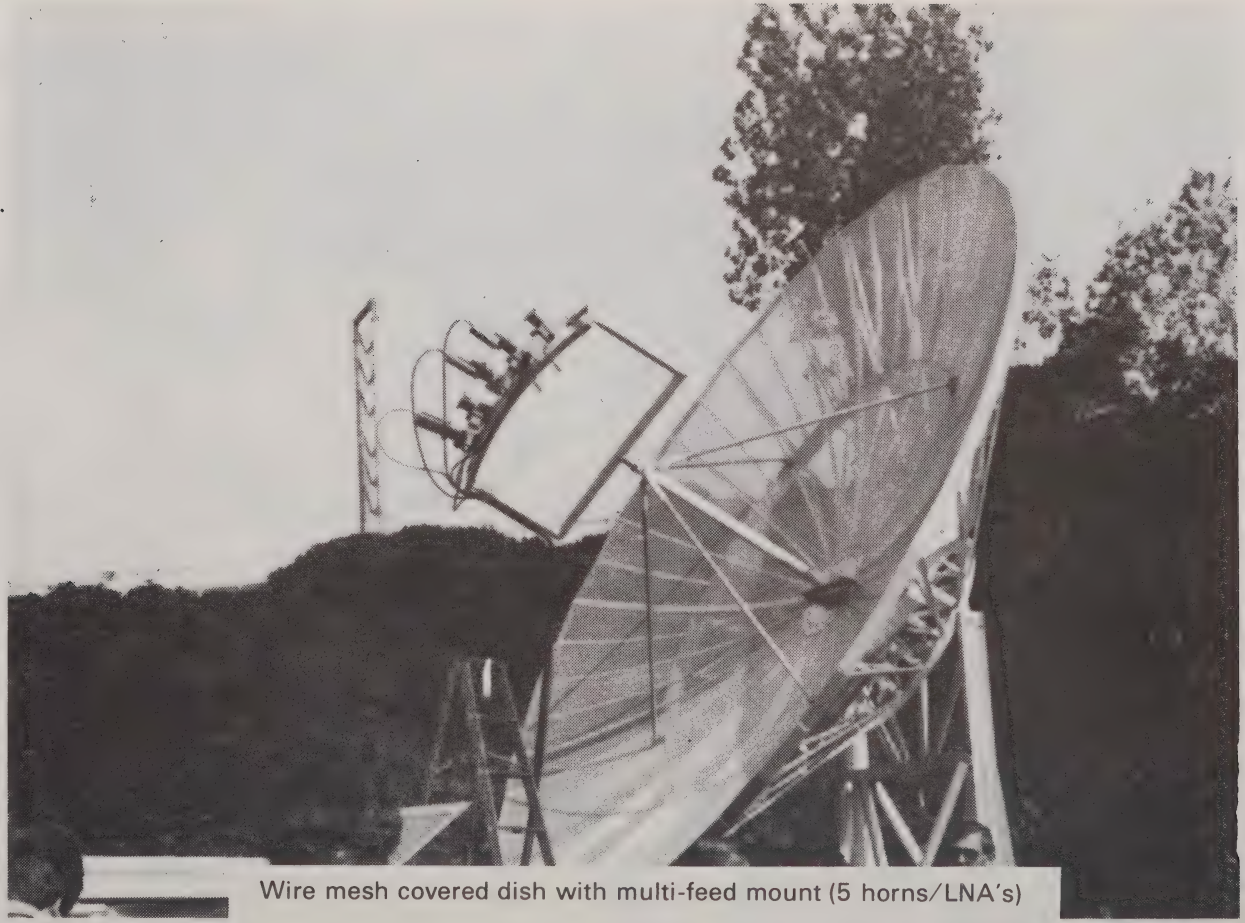


Standard 4GHZ Scalar Horn Feed.



Scalar Horn Feed with rotateable probe for different polarizations. Servo drive for probe on rear.

Closeup of Newtonian feed.



Wire mesh covered dish with multi-feed mount (5 horns/LNA's)

A second method is the indirect feed. The incoming signal, after being reflected and focused by the dish, comes into contact with a subreflector,which redirects the signal back in towards the dish. This has the effect that the focus of the dish is much closer to its base.

The subreflector is normally made from solid materials and should, preferably, exceed 4 wavelengths in diameter as a minimum, but should not exceed 1/3rd of the diameter of the main reflector, if losses due to obstruction of the dish are not to become excessive.

The main advantage of this method is that the feed can be supported from the centre of the dish, and a relatively light structure is needed to support the subreflector.

Disadvantages are that the subreflector needs to be aligned very accurately, and that some extra losses are involved compared with direct feeding.

Positioning the Feed

It cannot be stressed too strongly that the accurate positioning of the feedhorn is of maximum importance.

Having calculated the focal point of the dish by reference to the f/D ratio, the point in space which has to go just inside the mouth of the feedhorn, has been quantified.

It is necessary to ensure that the feedhorn is orientated precisely at the centre of the dish, and that the axis of the feedhorn LNA assembly is at 90° to the baseline of the dish.

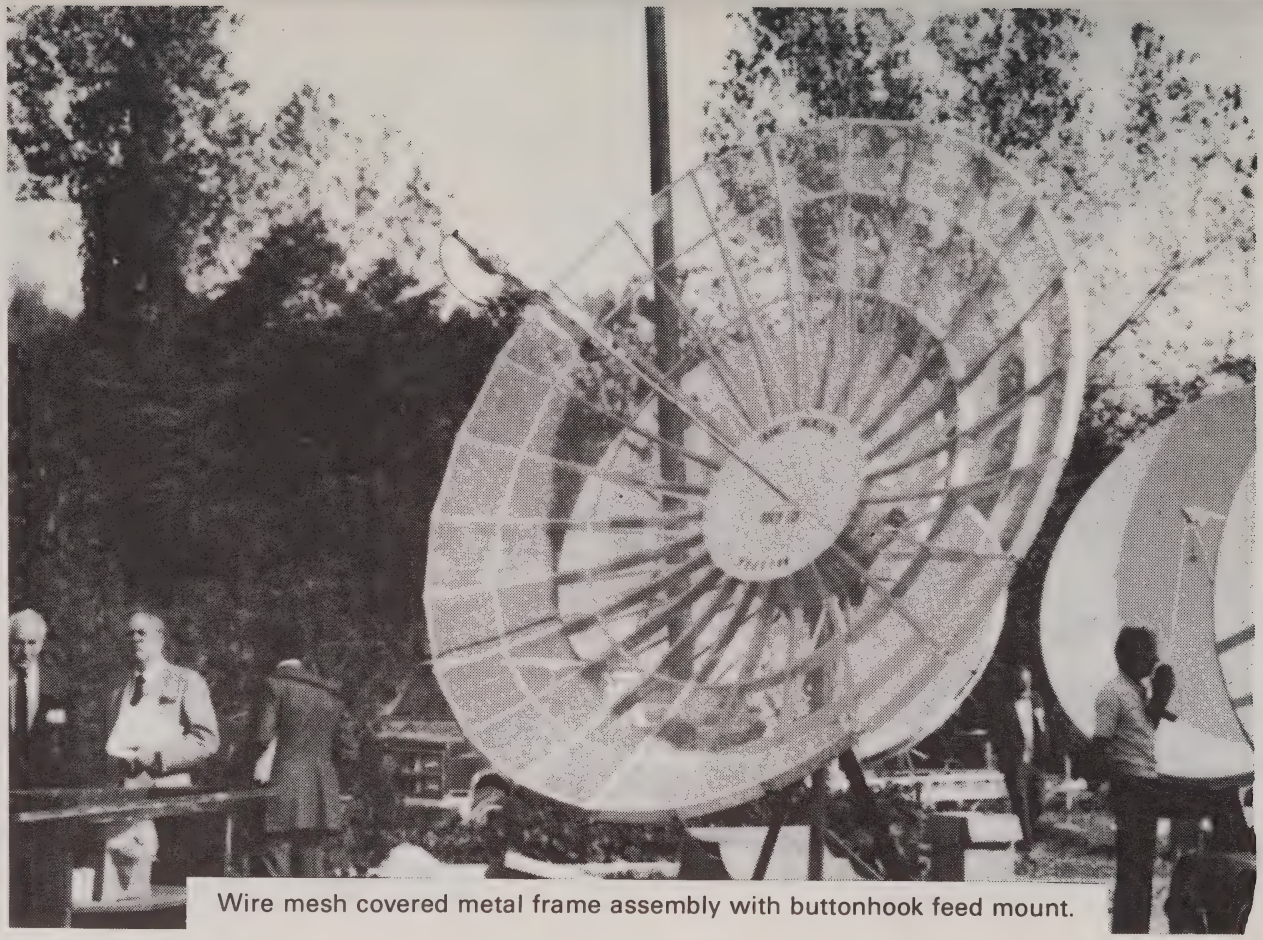
It is, if possible, best to leave a certain amount of vertical adjustment so that the positioning of the feedhorn can be optimised when the system is operating.

Feedhorn Mounts

The two most suitable types of feedhorn mounts are known as the buttonhook mount and the milkstool mount.

The buttonhook mount comprises a single tubular structure which has its origin in the centre of the base of the dish. Through the upper part of this mount being offset from the centreline, it enables the feedhorn LNA combination to be mounted very accurately with relation to the centre of the dish. Another advantage to this type of mount is that, adjustment on

Square bathtub style with tripod mount.



Wire mesh covered metal frame assembly with buttonhook feed mount.

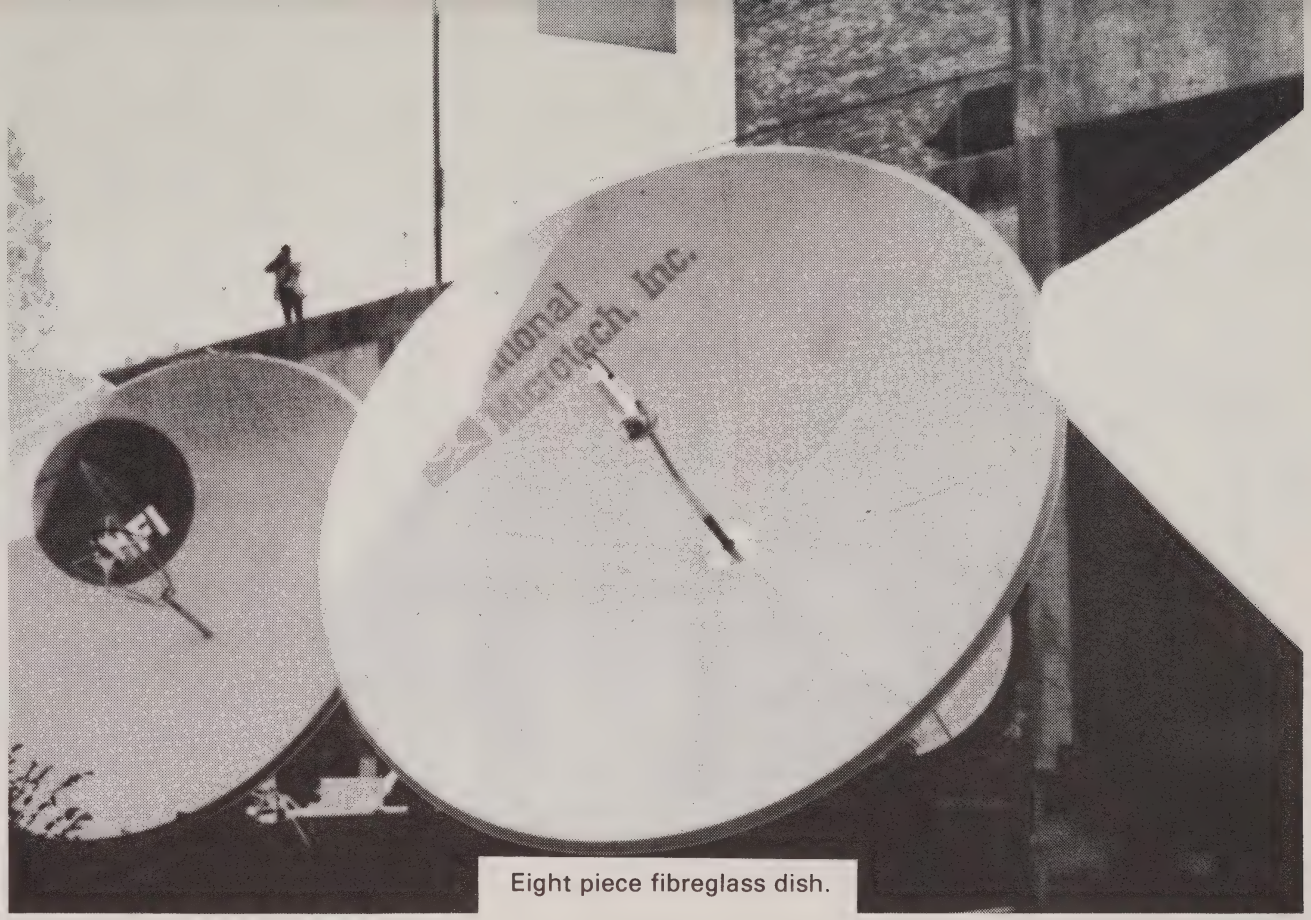
the distance from the horn to the centre of the dish can be effected from the rear of the dish, where the buttonhook mount is clamped to the main frame.

The milkstool mount is implemented by three or four tubular struts being attached to the ends of the formers supporting the dish. At the point where they join over the middle of the dish, a suitable mounting bracket is fitted to support the feedhorn LNA combination. Whilst being considerably more rigid than the buttonhook mount, it does suffer from the disadvantage of initially being difficult to set up accurately, and if any alteration in length is needed, it will be time consuming.

In order to obtain added rigidity with a buttonhook feed mount, small strainer wires can be run out to the periphery of the dish and adjusted for tension once the feedhorn LNA has been mounted.

The main thing to remember with any form of feedmount, is that it must hold the horn very accurately with regards to the dish, even when it is fairly windy. The smallest movement can result in a very large degradation of picture quality.

Whilst most LNAs and down converters are hermetically sealed at the time of manufacture, it is nevertheless a good idea to give some additional environmental protection to the units that are mounted externally, and it is to be recommended that a plastic cover is fitted around the electronic items mounted on the feedhorn. Also, any coaxial cable connections which are exposed to the environment need to to be liberally covered with a waterproof sealer, as the smallest amount of moisture, when inside a coaxial cable which is working at 4 gigacycles, can result in the total loss of the signal.



Eight piece fibreglass dish.

CHAPTER 5

LOW NOISE AMPLIFIERS (LNAs)

The Function of an LNA

The purpose of an LNA is to amplify the signal, which it receives from the dish via the feedhorn, up to a level at which it can be fed into the down converter. In the process of amplifying this signal it is extremely important that very little noise is added to the signal.

All electronic systems are noisy. Due to the molecular reaction within transistors noise is randomly generated at all times.

With normal audio amplifiers a hissing noise can be heard in the background when no signal is present. In order to reduce noise to a level that can be acceptable to receive satellite television, it is necessary to use Gallium Arsenide Field Effect transistors (normally referred to GasFets). The development of these very special transistors made possible the reception of very weak signals at an acceptable cost, and therefore helped to make a TVRO system a reality.

Prior to the development of GasFets, the only low noise amplifiers available were called parametric amplifiers. They were very expensive, and highly complex pieces of electronic equipment, which in some cases were cooled by liquid nitrogen. The development of the GasFet reduced the cost of LNAs to a level where TVROs became economically feasible.

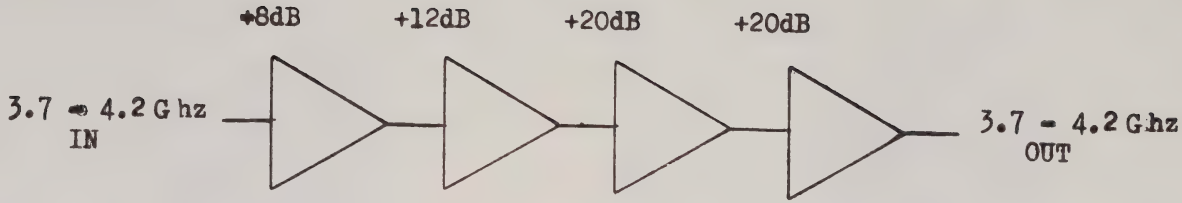
GasFets were first produced in Japan in the mid 1970's, but it took until 1981 until sufficient quantities could be produced at a reasonable price before mass production of LNAs could really start.

At the present time LNAs are still manufactured in relatively small quantities and hand-built, and during the manufacture of LNAs it is not known, until final testing, exactly what its noise rating will be.

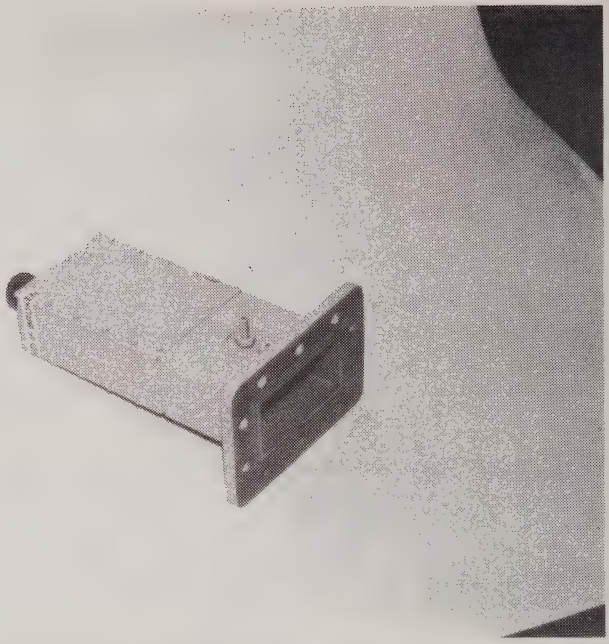
The Construction of an LNA

An LNA comprises a number of stages varying from 4 to 8, each stage amplifying the signal passed on from the stage immediately in front of it.

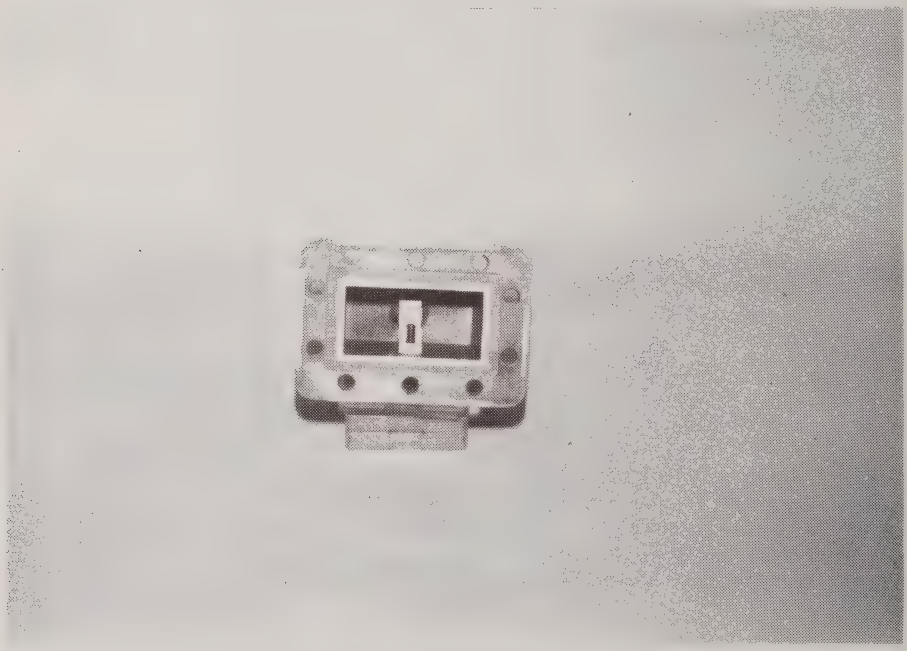
The first stage of the LNA is the point at which the overall noise level is set, since once noise has been induced into the circuitry it cannot be removed, and as the signal is passed from stage to stage it is essential that stages are matched to each other, in order to keep the noise level down.



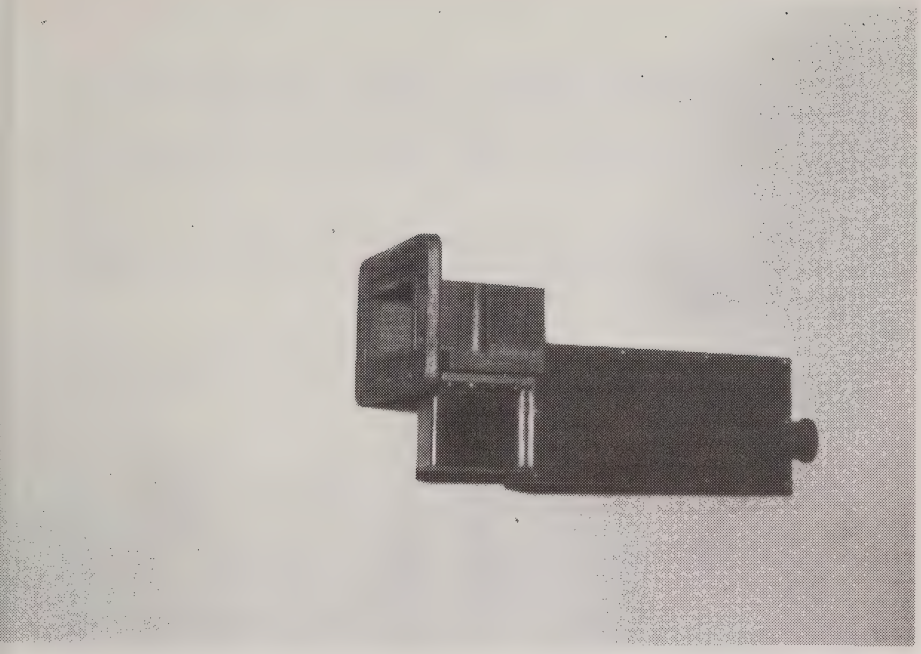
L.N.A. Block Diagram. *Note* 1st stage low amplification for minimum noise.



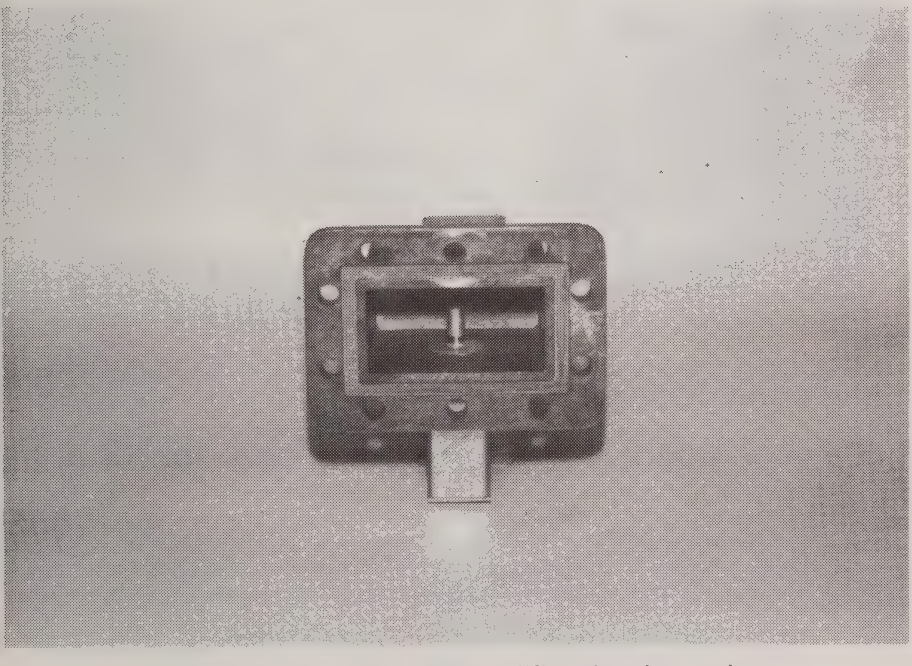
Low noise amplifier for 4GHZ band. *Note* Probe tuning screws.



Front view of low noise amplifier showing probe and tuning screw.



Low noise amplifier for 4GHZ band.



Front view of low noise amplifier showing probe.

The output frequency of an LNA is the same as its input, that is, 3.7 to 4.2 gigacycles. The unit functions only as a linear amplifier.

The electronics of an LNA are normally encapsulated within a hermetically sealed metal box.

At one end is the input, which consists of a flange which mates directly onto the feedhorn. Just inside the flanged area is the probe which gathers the signal after it has passed through the feedhorn.

The only other connections to an LNA are the power feed, which is normally 18 volts d.c. and the output for the amplified signal, although in some cases the power feed is passed up the signal output coaxial cable, resulting in only one connection.

Gain and Noise

The normal gain figure for a LNA is in the realms of 40 to 50 dB, that is, it amplifies the signal from between 10,000 to 100,000 times.

It is necessary to have this level of amplification, due to the fact that the signal received from a satellite would only be one millionth the amount of that received from a terestrial broadcasting station, and also, allowances have to be made for losses occurring between the LNA and the down converter when the signal is transferred by coaxial cable.

The noise factor of a LNA is normally expressed in degrees kelvin (°K).

To convert from °K to dB the formula is

$$dB = 10 \times \log \text{ of } \left(\frac{°K}{290} + 1 \right)$$

and conversely to change from dB to °K the formula is

$$°K = 290 \times (\text{antilog } \frac{dB}{10}) - 290$$

The normal noise temperatures of commercial LNAs available today vary from 150°K down to as low as 80°K.

From this you can see, at the lower end of the scale, that an 80°K LNA will have a noise figure approximating to 1.06 dB.

Therefore, you have the capability of an amplifier that will increase a signal 100,000 times whilst only increasing the noise by 1.27 times, which has to be a miracle of modern electronics.

Power for LNAs

As previously mentioned, in certain circumstances the nominal 18 volts that is required to power an LNA can be supplied via the radio frequency coaxial cable.

Many TVRO receivers supply a regulated 18 volts for this particular purpose. However, LNAs are very delicate, any excessive voltage spikes can destroy the Gasfets in the LNA easily.

For this reason a large number of users of LNAs power them from d.c. sources, such as accumulators, and in this way avoid any problems.

LNAs v. Dishes

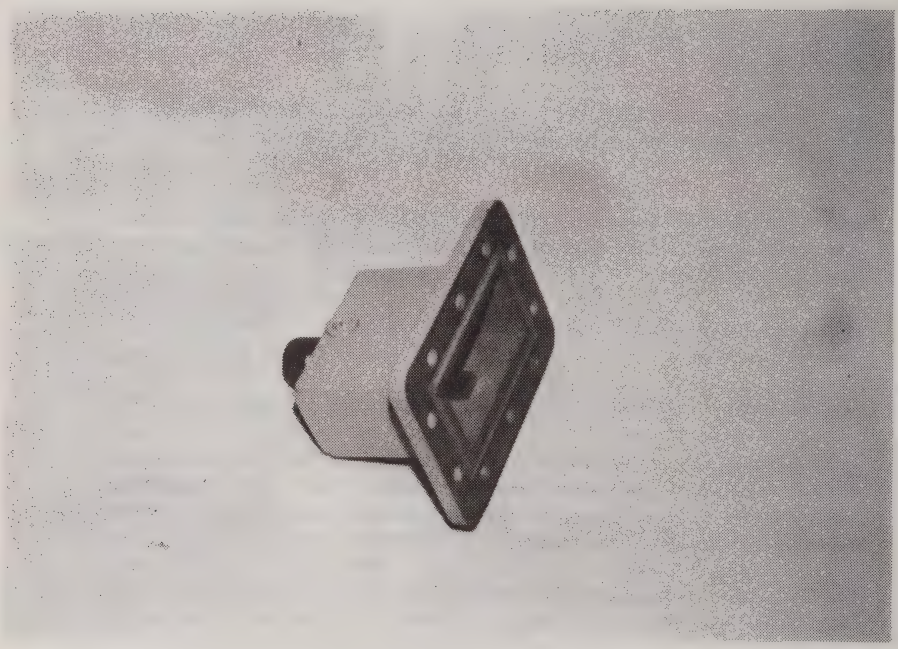
As previously discussed, the larger an antenna the more of the available signal it will capture, compared to a small antenna. Also, because the satellite signal is so weak, it can be eliminated by the noise coming from the earth, plus the noise contributed by the LNA.

There are therefore numerous combinations possible between the size of an antenna and the LNA noise temperature, which will result in a quality television picture. You can use a large antenna which captures more signal, and a low noise amplifier with a relatively high noise rating. This works because you have more signal available from the antenna to override the noise coming from the LNA.

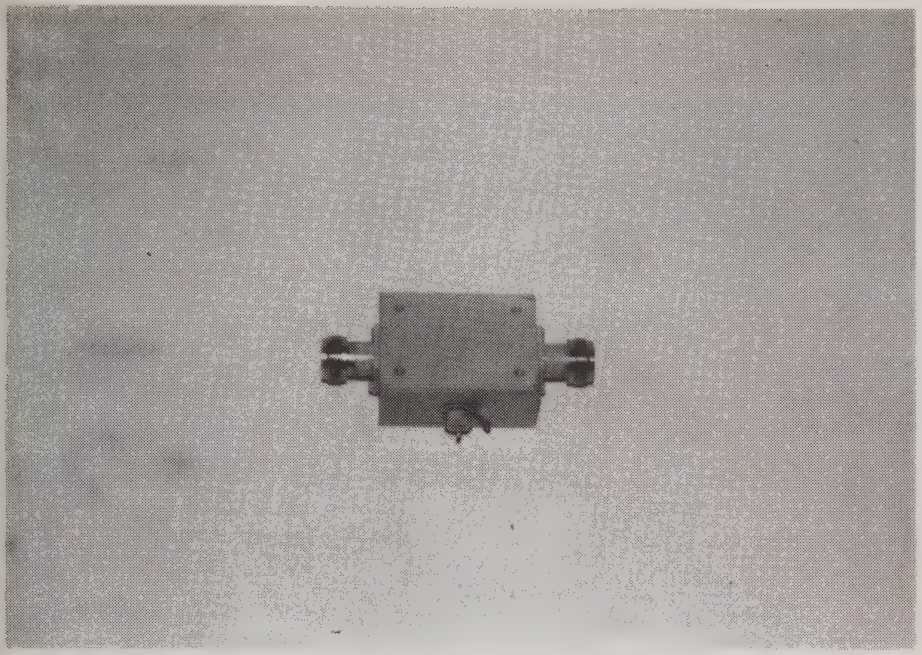
Or you can use a smaller antenna and a lower noise LNA. But it needs to be pointed out that there is a self limiting factor present. There is a practical size below which the antenna feed system begins to add into the formula appreciable amounts of earth noise. Noise, whether it comes from the LNA, the earth, or both, is still noise.

If an LNA with a feedhorn attached is pointed directly at the earth, the noise that will be seen will be close to 300°K. The LNA may well be a 100° unit but the noise temperature of the system at that point will be determined by the highest noise, that is the earth noise, not the LNA noise.

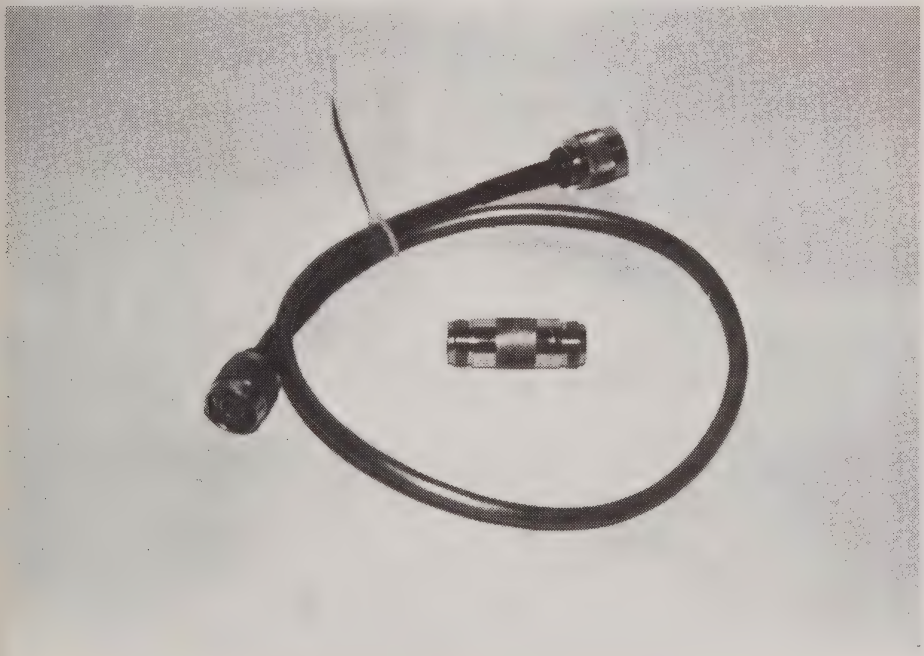
The important thing to understand is that, at a certain point in the design of a system, a lower noise amplifier will not improve the performance of the system, because the noise temperature of the antenna becomes the



Probe assembly for use when low noise amplifier is separated from the feed horn. The signal is transferred by cable, but can lead to losses and increase in noise. This assembly would be used in extreme environmental conditions.



Power block for connecting 18 V.D.C. source into L.N.A. to down converter cable for powering L.N.A.



4GHZ cable with S.M.A. connectors.

primary noise element, and the system will only be as good as the highest noise factor within that system. If the antenna is putting noise into the system which is greater than the noise rating of the LNA, then the antenna noise will be the base for that system.

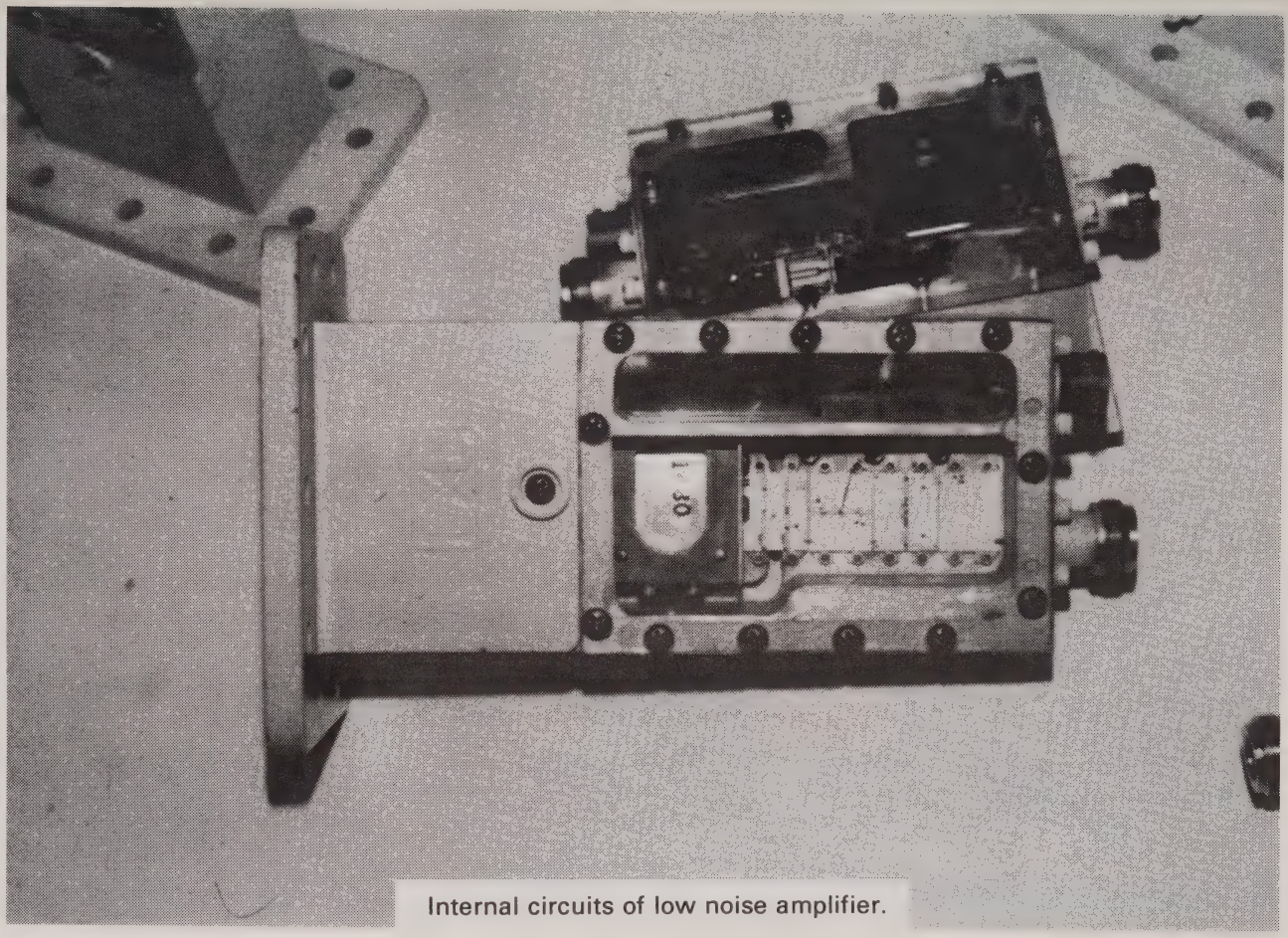
Low Noise Converters (LNCs)

A recent innovation has been the development of the LNC, which combines the LNA with the down converter.

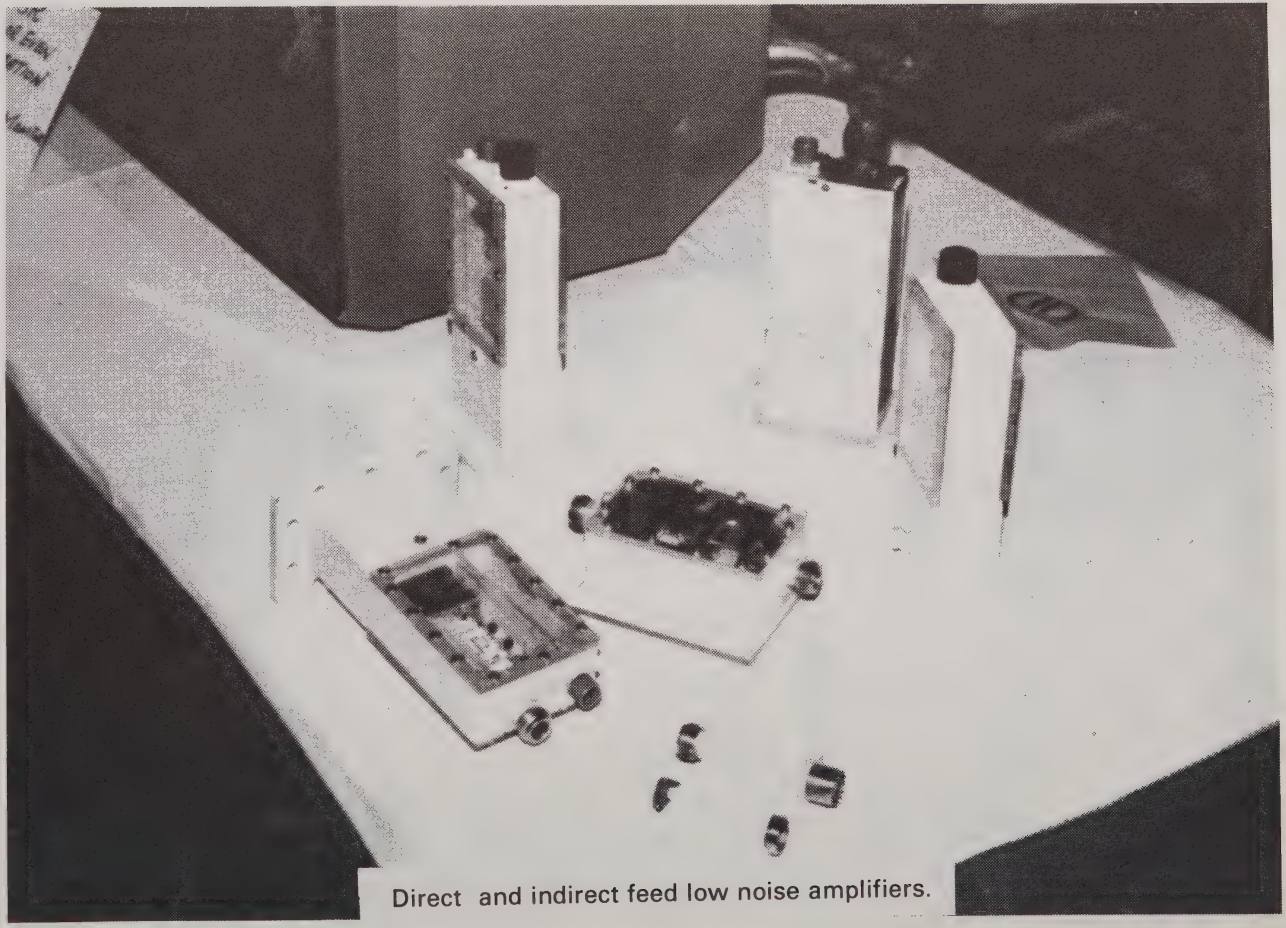
There are advantages and disadvantages to this form of system. One advantage is that the LNA section can be fitted with far fewer stages of gain since it has no longer to compensate for signals lost between the LNA and the down converter. Normally, about 30 dB of gain is the requirement for an LNC. The other major advantage is, that because of the saving of cost in manufacturing, an LNC can be produced at a far more advantageous price than the two separate items of an LNA and a down converter.

It does however, have a couple of disadvantages. For instance, the choice of receiver is completely limited to those which are compatible with the LNC and generally it will be found that no two manufacturers will produce compatible LNCs.

The other disadvantage is, that if anything were to go wrong within an LNC, it would mean the removal and possible replacement of a large section of the system, as opposed to a smaller component block in the case of an LNA with separate down coverter.



Internal circuits of low noise amplifier.



Direct and indirect feed low noise amplifiers.

CHAPTER 6

DOWN CONVERTERS

The purpose of a down converter is to change the signal output from an LNA, which is at a frequency of 4 gigacycles, down to a level of 70 megacycles. The reason for this is two fold. Firstly, coaxial cable suitable for usage at 4 gigacycles is very expensive, and the losses to the signal involved at this frequency, when using any appreciable length of coaxial cable, is very high. Secondly, when processing the received signal, the electronic components are readily available from normal television and electronics technology, providing this processing is done at a 70 megacycle level. To attempt to do this at 4 gigacycles would be pointless and very expensive.

Types of Down Converters

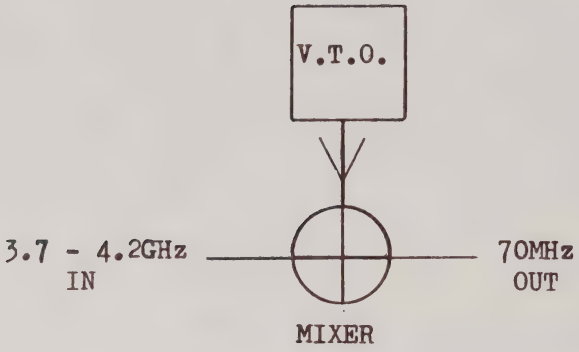
There are two main types of down converters, these being the single stage down converter and two stage down converter.

There are advantages and disadvantages with both types. The single down conversion technique employs less electronics to convert the signal from 4 gigacycles down to 70 megacycles, this of course results in a less expensive unit with fewer items to fail. However, it does have the disadvantage that stray radio energy from the LO frequency source can escape and cause interference, as it is extremely near in frequency to that being tuned by the receiver.

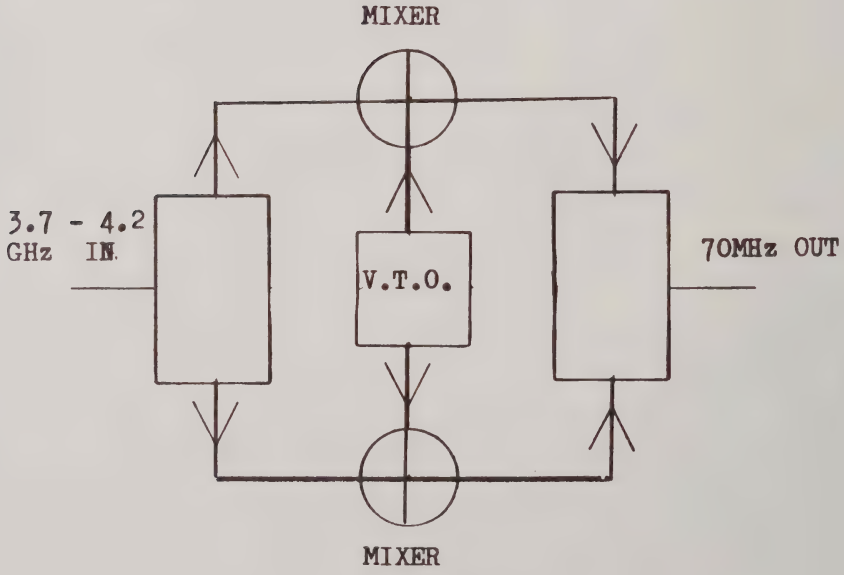
The normal format for a single stage down converter is to have a LO oscillator, which is tuneable between 3630 megacycles and 4130 megacycles. When this is mixed with the incoming RF signal from the LNA, at between 3700 megacycles and 4200 megacycles, the IF generated will be centred upon 70 megacycles.

In the case of a two stage converter, the first LO source would be tuneable between 2900 megacycles and 3400 megacycles. When mixed with the incoming signal this would give a frequency of 800 megacycles, which would then be mixed with the second LO source, which is fixed at 730 megacycles, thereby giving the IF of 70 megacycles.

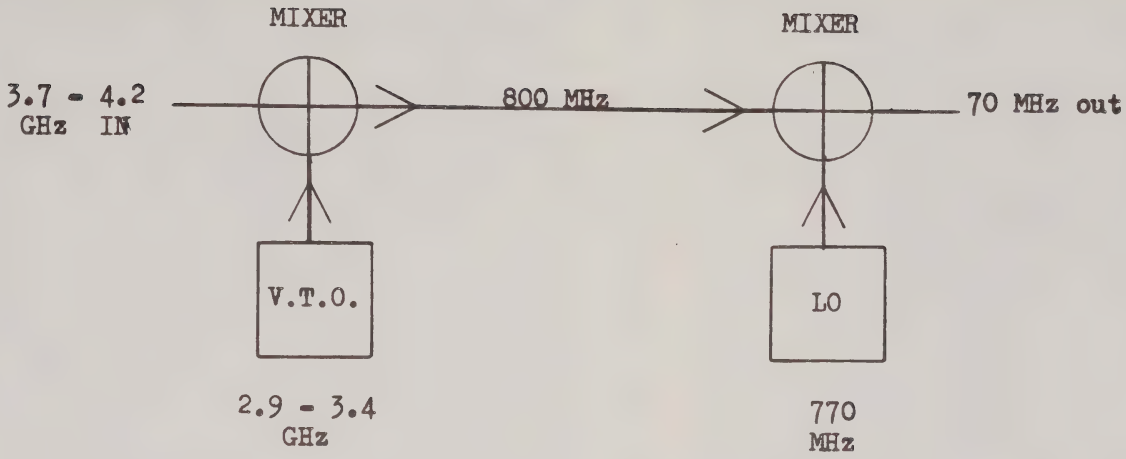
As can be seen, in the case of a two stage unit, this arrangement allows the oscillators to be set at frequencies far enough apart that the mixers can differentiate between them, and prevent the signals from being retransmitted by the first mixer. The images are also out of bounds and well beyond the tuning range of the receiver. This circuit is very free of any extraneous signal noise, but it is also more expensive and complex than the single stage converter.



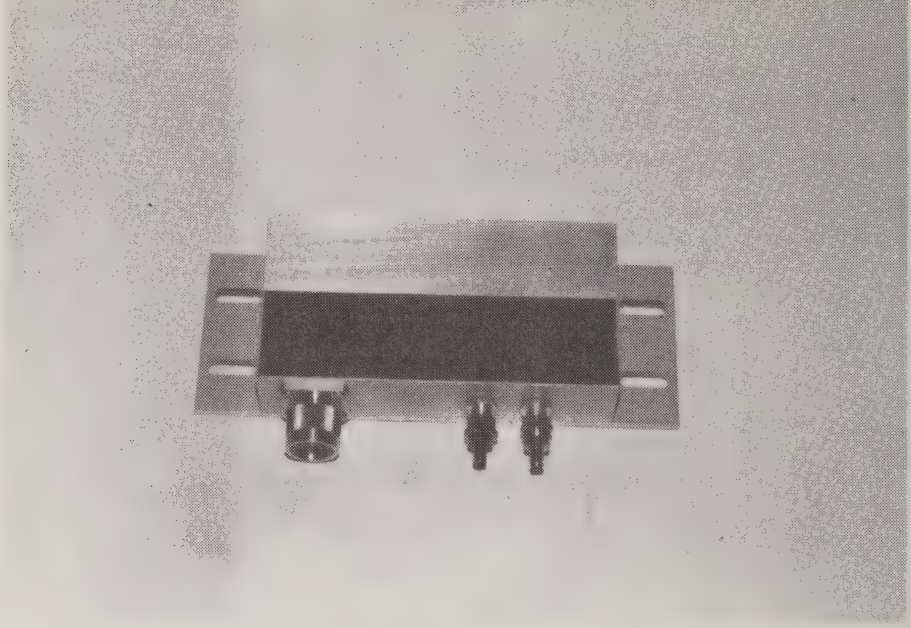
Single stage mixer.



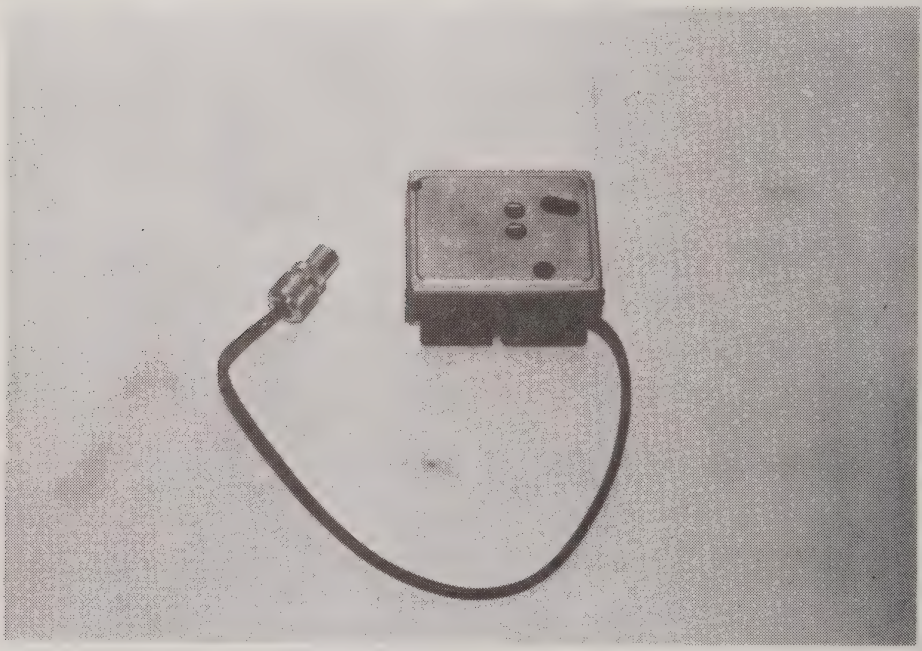
Single stage image reject mixer.



Two stage mixer.



Down converter. Left to right. 1) Signal in from L.N.A. 2) 18 V.D.C. in. 3) 70MHZ signal out.



Video modulator. Audio/visual in. Standard T.V. Signal out.

The down converter would normally also include at least a single stage of amplification, to make up for the losses involved in the mixing of the signals.

The tuning function of the LO sources is effected electronically by a d.c. voltage, which can either be separately connected to the down converter, or is, as more normal sent up the 70 megacycle out RF coaxial cable. Since it is a d.c. signal, it is transparent to the RF signal on the coaxial cable.

Positioning the Down Converter

In order to minimise losses when transferring the 4 gigacycle signal by a coaxial cable, the ideal position for the mounting of the down converter is immediately adjacent to the LNA. However, the environmental conditions found in this position will not always cause it to be the most suitable.

Whilst transmission of a 4 gigacycle signal by coaxial cable will result in some losses, providing that the LNA has sufficient gain (in the region of 50 dB), it will not present a major problem to mount the down converter on the framework at the base of the dish.

A major advantage of doing this is that an attempt can be made to stabilise the temperature of the down converter. No matter how carefully designed, the LO source will have characteristics of frequency instability relative to the ambient temperature and therefore the mounting of the down converter in a box, which can have a level of insulation in order to attempt to stabilise the temperature, will have long term advantages in tuning stability. However, as a last resort, one can have the down converter fitted onto or inside the receiver itself. However, large losses will occur on the coaxial cable run from the LNA to the receiver, and also, the cable which it is necessary to use at the 4 gigacycle frequency is expensive, heavy and prone to damage if at all harshly treated.

Feed from Down Converter to Receiver

Since the signal output from the down converter is now at a frequency of 70 megacycles, it is quite acceptable to use standard low loss coaxial cable for the run to the receiver.

And, since the output strength of this signal is fairly high, quite a long distance of cable can be utilised, thereby allowing the antenna and down converter to be positioned a considerable distance away from the receiver.

CHAPTER 7

THE RECEIVER

After the signal has been converted down to a 70 megacycle level, it is now passed to the receiver, which processes this signal to the point where it can be displayed on a standard television.

Signal Processing

The 70 megacycle IF signal is first amplified in order to make up for any losses that may have occurred between the down converter and the receiver. It is then proceessed by the bandpass filter which sets the overall bandwidth of the signal. This signal is then demodulated to form the base-band signal. At this point the dispersion signal, which is present in the audio and video signal, is clamped. The audio and video signals are then separated and fed to a UHF modulator, which outputs a signal compatible to a normal television set.

Bandpass Filter

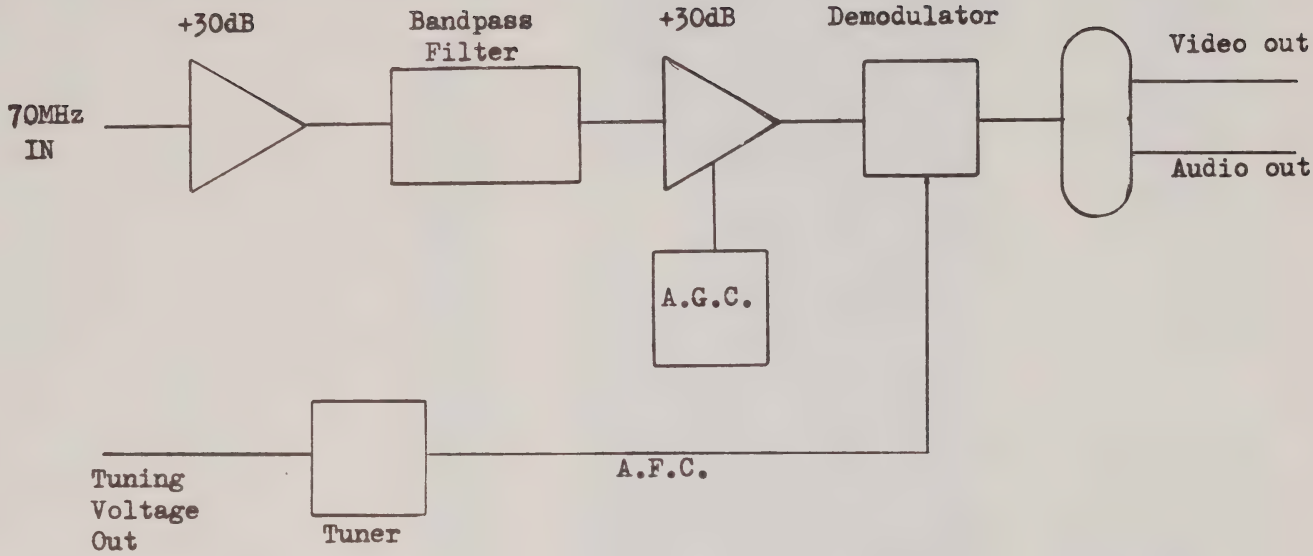
The function of the bandpass filter is to limit the bandwidth of the IF signal to be processed by the receiver.

The American domestic satellites and the Russian Gorozont satellite's transmit a bandwidth of 36 megacycles, but the majority of Intelsat transmissions use an 18 megacycle bandwidth.

Normally, a receiver would be set up to have a bandwith of between 26 megacycles and 30 megacycles for reception of the 36 megacycle transmitted bandwidth, and for an 18 megacycle wide transmitted bandwidth between 12 and 15 megacycles would be normal.

There are some advantages to be had by limiting the bandwidth processed by the receiver, and this will be discussed in detail later.

Two main types of bandpass filters are normally utilised. These being, the standard discrete assembly which is made out of coils and capacitors. Whilst not complex to assemble, this system does require very accurate setting up, which can only be achieved by the use of a wideband signal generator and spectrum analyser. The alternative to this, is the use of SAW (Surface Acoustic Wave) filters. These are available packaged as integrated circuits and manufactured to work within a specific band, and to have specified bandpass characteristics. Whilst being more expensive than the conventional system, they require no alignment whatsoever, and are, of course, very easy to change, if an alternative bandwidth is required.



Receiver block diagram.

Satellite T.V. receiver front view. *Note* 2 mono sound channels. 2 stereo sound channels. AFC on-off switch. Video inversion switch. Channel scan switch. odd/even selection for auto polarization adjustment.

Satellite T.V. Receiver. Rear View. *Note* Subcarrier tuners for mono and stereo sound. Power for polarization adjustment. 70MHZ output (test). Audio/Video/18V out. 70MHZ input from down convertor.

Demodulation

This part of the receiver senses the modulation contained on the carrier, and extracts this for processing.

It is necessary to have a flat, highly sensitive demodulator in order to ensure good video response.

There are a number of basic designs in common use. The most popular of these is the PLL (Phase Lock Loop). This circuit is implemented using a readily available, commercial integrated circuit, which is a limiter/ demodulator. In early designs, the 70 megacycle signal was fed directly to the PLL, but due to the lack of response at the frequencies being processed, generally the 70 megacycle signal is now fed through a divide by two circuit prior to processing by the PLL.

Another popular system is by the use of a coaxial delay line demodulator.

The IF output is split and half of the signal goes directly into a mixer. The other half of the signal is passed through a precisely measured piece of coaxial cable, and then to the second part of the mixer. The delay that is imparted to the second half of the signal causes it to be 90° out of phase with the first part. This results in a phase cancelling of the carrier, and the audio and video information is output from the mixer unit.

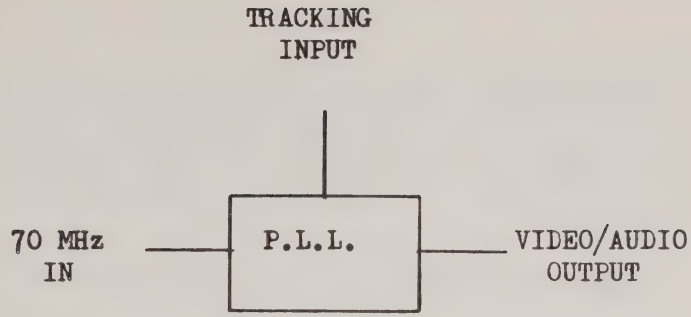
As a variation to using coaxial cable as the delay line, it is possible to use a digital delay integrated circuit. However, because of the complexity and high cost of the components, it is a rarity to see this implemented.

The third type of demodulator consists of coils and capacitors which detect the modulation and then removes the information from the carrier. However, the circuit suffers from input sensitivity and is rarely used in domestic TVRO systems.

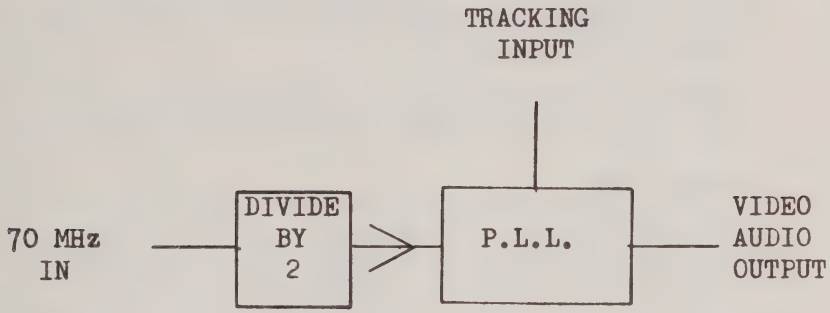
Video Processor

Having processed the RF signal, we now have coming from the demodulator a baseband signal (audio and video) ready for separation and processing.

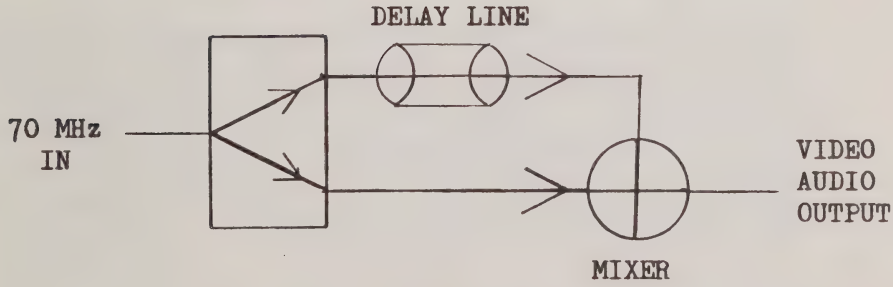
The video processing circuit serves several functions. Firstly, the video must be detected and filtered in order to remove the audio sub-carrier. This filtering process will attenuate any signal above approximately 5 megacycles.



P.L.L. Demodulator.



P.L.L. Demodulator with divide by 2 input.



Delay line Demodulator.

Clamping is also implemented, in order to remove the energy waveform dispersal, which is the signal superimposed on the carrier at the uplink site. This energy waveform prevents the power of the transponder from being concentrated on any one frequency in the bandwidth, and is implemented in order to avoid any interference with terestrial microwave transmissions.

If this signal is not completely removed by the receiver, distortion and instability will appear on the television picture.

Whilst the video picture is now fed into the modulator without any further processing, it is necessary that the audio signal is tuned to the correct frequency of the sub-carrier on the satellite. These sub-carriers can vary between 5.5 megacycles and 7 megacycles, and it is necessary on any receiver to have a tuner in order to discriminate between the different frequencies that are transmitted.

The two signals, video and audio, are now modulated in the UHF band and the signal output can be fed directly into a standard television receiver.

Receiver Options

What has been described is the minimum configuration for a TVRO receiver. However, there are a number of options which, whilst not absolutely necessary, nevertheless can be extremely useful.

Whilst continuous tuning of audio is an absolute necessity, detent tuning of the video channels can be accepted, providing there is a means of fine tuning the channel selection. However, it is more advantageous if continuous tuning can be implemented over the entire 4 gigacycle band.

On occasions the transmissions from a satellite will use a rudimentary form of scrambling by inverting the transmitted signal, and it therefore is extremely useful to be able to return this signal to its standard format. This would normally be referred to as a video invert capability.

A form of AFC (Automatic Frequency Control) will be implemented on all receivers as a standard feature. It will be convenient on occasions to have the opportunity of switching it off. Due to the wideband nature of this receiver, if one is trying to receive a relatively weak signal, and there is a stronger signal being transmitted on a frequency within the bandwidth, the AFC would immediately lock on to the stronger signal and,therefore, the opportunity of removing this automatic function would allow the weaker signal to be satisfactorily tuned.

Another extremely handy option is that of the receiver scanning the full range of the 4 GHz band. This capability is most useful when initially setting a system up, as by leaving it scanning at the time of aerial adjustment, it can give an indication of when the aerial is correctly aligned on the satellite.

The receiver, of course, contains all of the tuning circuitry to generate the d.c. signal, which is transmitted to the down converter. It is also normal for the receiver to act as the power source for the down converter and LNA.

C/N Ratio (Carrier to Noise Ratio)

Having now discussed the various components to make up a satellite earth station, it is possible to mathematically define from the many variables, the capability of resolving a satisfactory picture on a television.

In the final analysis this is defined as the carrier to noise ratio that a receiver is capable of discriminating. Normally, receivers will have a threshhold in the range of 7.5 dB to 9 dB.

We can now calculate, from a hypothetical system, the carrier to noise ratio delivered to a receiver. For example, if we take an 8 ft dish which has a gain of 37.5 dB, and a noise temperature of 32°K, a 120° LNA, and we wish to view the Russian Gorosont satellite, which has an EIRP of approximately 36 dB in the United Kingdom, the formula that we will use is

$$\text{C/N Ratio} = (E - L + G) - 10 \times \log (T \times B \times N)$$

Where
- E = Satellite E.I.R.P.
- L = Path Loss In dB
- G = Dish Gain
- T = L.N.A. Temp + Antenna Temp in °K
- B = Boltzmans Constant = 1.381^{-23}
- N = If Bandwidth (e.g. 30 MHz = 30^{6})

Therefore, by substituting the above theoretical system, the calculations will be as follows

$$\begin{aligned}\text{C/N Ratio} &= (36 - 197 + 37.5) - 10 \times \log (152 \times 1.381^{-23} \times 30^{6}) \\ &= (-123.5) - 10 \times \log (6.297^{-14}) \\ &= (-123.5) - (-132) \\ &= 8.5 \text{ dB}\end{aligned}$$

As can be seen, this system would give a carrier to noise ratio of 8.5, which, with a normal receiver, would result in a viewable but not high quality picture.

In the example above, the bandwidth of the receiver has been taken as 30 megacycles. In the following example, all other items will remain the same values except for the bandwidth, which will be reduced to 15 megacycles.

$$\begin{aligned} \text{C/N Ratio} &= (36 - 197 + 37.5) - 10 \times \log (152 \times 1.381^{23} \times 15^{6}) \\ &= (-123.5) - 10 \times \log (3.149^{-14}) \\ &= (-123.5) - (-135) \\ &= 11.5 \text{ dB} \end{aligned}$$

As will be seen, this reduction in the bandwidth has resulted in an increase in carrier to noise ratio of 3 dB. This is the equivalent of doubling the size of the antenna. However, it must be pointed out that, in a situation where the signal is being transmitted on a 30 megacycle bandwidth, and the receiver is only processing a 15 megacycle bandwidth, that a certain loss of quality in the picture will result but, as a balancing factor, it does give the capability of resolving some pictures using the narrow bandwidth that would be impossible to resolve using the full bandwidth.

As can be appreciated, there is no reason to stop at halving the bandwidth and, in circumstances where the EIRP of a satellite is very low, it may still be possible to resolve pictures using as low a bandwidth as 5 or 6 megacycles. Whilst not giving a good picture it may be better to have some reception than none whatsoever.

The CNR will indicate to you as to what quality of picture you will be likely to get in any set of circumstances. Receivers will vary slightly as to the picture quality delivered by any given CNR, due to the differences in their design and the noise temperature of their internal components. However, generally speaking, the list below will give you an indication of the type of picture you can expect to receive from an average receiver.

CNR below 6 - Poor quality picture, little detail, no colour, lots of noise with sparkers.

CNR 6 to 8 - Marginal reception, some colour, noise level still apparent.

CNR 8 to 10 - Good reception, good colour, slight noise evident.

CNR above 10 - Very good reception, sharp picture, excellent colour.

From a study of the formula used to determine the CNR, it will become apparent that the only two items which are worthwhile modifying in the system are, firstly, the dish gain, and secondly, the IF bandwidth. If it is possible to increase the size of the dish and therefore obtain more gain, this will be the easiest way of improving the CNR. Alternatively, if some degradation in the picture quality is acceptable, then the reduction of the IF bandwidth will be the choice to make.

All the other items used in the calculation are either constants, or their variation will have little effect on the CNR.

CHAPTER 8

ANCILLIARY EQUIPMENT

Having detailed the main components involved in the satellite television reception system, there are a number of additional items which are either essential for the system, or extremely useful in ensuring its correct operation.

Coaxial Cable and Connectors

The correct choice of coaxial cable is important in order to avoid any unneccesary losses in the signal during its transmission from the antenna to the receiver.

When transferring signals between the LNA and the down converter it must be remembered that the frequency is in the 4 gigacycle range, and in order to minimize loss it would be necessary to use a hard line cable. Whilst very thick, between one half and three quarters of an inch diameter, and relatively expensive to buy, hard line cable can give losses as low as 10 to 15 dB for a 100 ft. run.

Reference numbers RG-14A/U and RG-17A/U are the two most suitable types to use.

For short cable runs where the down converter would be mounted at the base of the anntenna, it becomes feasible to use RG-58/U, which would have a loss of approximately 50 dB per 100 ft run, and therefore, providing the interconnection was kept to a short length, the losses would be acceptable.

Once the signal has been down converted to the 70 megacycle range, it then becomes practical to use standard coaxial cable, reference number RG-59A/U, which would only have a loss of 3 dB per 100 ft. run at 70 megacycles.

Normal impedance between the LNA and the down converter is usually 50 ohms, and between the down converter to the receiver 75 ohms.

Connectors used in conjunction with the coaxial cable need to be suitable for use at the frequency being transferred. When working in the 4 gigacycles range SMA brand connectors are the best and when transferring in the 70 megacycle range any good quality UHF rated connectors would be quite suitable.

Any connections that are made must be adequately waterproofed by the application of a suitable tape between the coaxial cable and the connector, and once the connector is fitted to the LNA or down converter a covering of a waterproof mastic is highly recommended. The ingress of the smallest amount of moisture can cause the signal to be blocked, particularly at 4 gigacycles, and a cable once contaminated, can never be satisfactorily put in use again.

In all instances after making up cables, check that no short circuit has occurred between the outside sheath and the inner conductor at the connectors since, particularly where cables are carrying d.c. power to the down converter or the LNA, this can have disastrous effects on the power supply.

Certain of the connectors that are used require a circular ring to be crimped in order to facilitate a solid connection. The tools for doing the crimping are very expensive. A suitable alternative is to take a small block of solid aluminium and drill a hole through it to the size that the ring needs to be when crimped. The block then needs to be cut with a fine saw through the centre of the hole. The two pieces, when placed either side of the ring and smartly struck with a hammer, will cause an effective joint to be made.

Interference Filters

The best receiver, and LNA combination, is no match for strong microwave signals which emanate from terestrial sources. Interference from these sources can be exceedingly strong and occur almost anywhere across the 4 gigacycle band. In the first instance, it is wise to check for interference, before the antenna is permanently located, since moving the antenna only a short distance may remove the problem.

If it is found that no suitable position is free of interference, the first thing to do it to identify the direction that the interference is emanating from and attempt to shield the antenna from the signal. This can be done by erecting a small area of wire mesh, where the gap in the mesh would be no more than ½" in its longest direction. This mesh would be placed between the antenna and the perceived source of the signal.

The final cure for this interference would be the use of a filter, although it must be said that, as you remove the interference, you cannot avoid losing some picture detail.

Filters fall into two main classes, the first being a filter for out of band interference, where an exceedingly strong signal is being received by the LNA from outside the 4 gigacycle band but causing the LNA to go into saturation, resulting in interference over the whole of the band. The cure for this is to fit a band pass filter, which will allow frequencies between 3.7 and 4.2 gigacycles to pass, with a small amount of loss, but all signals outside of this band would be suppressed by about 50 dB.

The second type of interference found comes from transmissions within the 3.7 to 4.2 gigacycle band, and normally fall on the edges of the individual channels within the band. In order to cure this, filters would be inserted between the down converter and the receiver, operating in the 70 megacycle band. It is necessary to identify the frequency relative to the 70 megacycle centre point and to fit a notch filter to remove the offending signal. The normal depth for such a notch would be in the region of 30-40 decibals and the width of the filter would need to be minimized to a level sufficient to remove the interference without unduly limiting the signal being passed to the receiver.

Signal Strength Meters

An extremely useful accessory to have is a signal strengh meter, which is capable of being inserted between the down converter and the receiver, in an external position very close to the dish.

When attempting to align the dish on a particular satellite the receiver can be set either to a known channel that the satellite is transmitting on, or if fitted, the receiver can be set to scan the whole band. Thus, when aligning the dish a visual indication can be given when a signal is received.

Also, in the circumstance that you wish to check if a system is working in the absence of a signal, it is possible to generate very short range signals in the 4 gigacycle bandwidth through the usage of a fluorescent tube.

These are readily available nowadays working from a 12 volt battery source.

If the neon tube is passed very close in front of the feedhorn when the system is fully powered up, a large increase in the background noise level on the T.V. receiver, and an indication on the signal strength meter, will result. Whilst not a very sophisticated method of checking, it will at least show that a signal is being passed the full length of the system.

Remote Dish Movement

By the usage of electrically powered actuating arms, it is feasible to alter the position of a dish by remote control. These arms normally take the form of a screwthread drive, rather similar to a car jack, which is driven by a 12 volt d.c. motor. In the case of an AZ/EL mount it is necessary to have two such units, and in the case of a polar mount a single unit.

Through the use of solid state electronics, the relative position of the dish can be tracked, and by adding memory circuits the dish can become a fully automated unit.

In order to avoid the cost and complexity of an electrically driven unit, it is quite practical to fit hand operated adjusters onto an antenna, although this will involve a trip outside each time a different satellite is to be accessed.

CHAPTER 9

WHAT'S BEING BROADCAST

At the present time there are twelve satellites broadcasting television programmes for at least part of the day, every day, in the 4 GHz band, and whilst none of these are orientated specifically for reception directly at home, they nevertheless can provide very interesting viewing.

The following is a list of satellites which are viewable from Europe, starting from the east, passing over the meridian and descending into the west, that is, from a position facing due south the satellites would start on the left-hand side, passing high above the horizon, and descending on the right-hand side.

This list includes all satellites which are in orbit at the present time, and a number that will be orbited within the next two years, regardless of the fact of whether they are transmitting television at the present time or not.

Due to the very varying nature of the people supplying the television programmes, and the demands of the countries receiving them, programming is often moved from one satellite to another, and as more countries become involved in the technology of satellite television, more of these satellites will be used for the relay of programmes. Therefore, because a satellite is shown as not transmitting television at the present time, it is nevertheless worth checking out on a fairly regular basis, as programming can appear overnight.

Details are given of the satellite type, its position, the frequency band that it is transmitting in, its polarisation and what known TV transmissions occur on a regular basis, together with an estimate of the EIRP.

Also given for each satellite, is a summary of the channels that it is capable of transmitting on, together with their individual frequencies, the polarisation used and the type of beam.

The format of this transponder summary is as follows

CHANNEL	1
CENTRE FREQUENCY (MHz)	3995
TYPE OF BEAM	G
POLARIZATION	R.H.

BEAM TYPES

G	GLOBAL
H	HEMISPHERIC
CONT	CONTINENTAL
EB	EUROBEAM
Z	ZONE
S	SPOT

POLARIZATION

H	HORIZONTAL
V	VERTICAL
RH	RIGHT HAND CIRCULAR
LH	LEFT HAND CIRCULAR

POSITION 63° east
SATELLITES Intelsat IVA F6 and Intelsat V F4
POLARIZATION Circular (linear on 12 GHz section of Intelsat V)

CHANNELS (IVA)

1	2	3	4	5	6	7	8	9	10	11	12
3725	3765	3805	3845	3885	3925	3975	4015	4055	4095	4135	4175
H/S	S/G	H/S	S/G	H/S	G	H/S	G	H/S	G	H/S	G
R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.

Channels are 36 MHz wide

HALF-TRANSPONDER FREQUENCIES (IVA)

	1	2	3	4	5	6	7	8	9	10	11	12
A.	3715.75	3755.75	3795.75	3835.75	3875.75	3915.75	3965.75	4005.75	4045.75	4085.75	4125.75	4165.75
B.	3734.25	3774.25	3814.25	3894.25	3934.25	3034.25	3984.25	4024.25	4064.25	4104.25	4144.25	4184.25

Channels are 17.5 MHz wide
BEAM PATTERN AND POLARIZATION REMAIN THE SAME AS FULL-TRANSPONDER USAGE

63° east (Cont'd)

CHANNELS (V)

1	2	3	4	5	6	7	8	9	10	11	12
3742.5	3742.5	3825	3825	3905	3905	3995	3995	4055	4095	4135	4177.5
H	Z	H	Z	H	Z	H/G	Z	H/G	G	G	G
R.H.	L.H.	R.H.	L.H.	R.H.	L.H.	R.H.	L.H.	R.H.	R.H.	R.H.	R.H.

Channels 1 - 6 are 72 MHz wide, 7 and 8 are 77 MHz wide, 9 - 11 are normal 36 MHz wide, 12 is 41 MHz wide

CHANNELS (V)

1	2	3
11099.2	11155	11577.5
S	S	S
V	V	V

Channel 1 is 77 MHz wide, 2 is 72 MHz wide, 3 is 241 MHz wide

T.V. Transmissions	Channel	E.I.R.P.
None known		

POSITION 60° east
SATELLITES Intelsat IVA F3 and Intelsat V F1
POLARIZATION Circular (linear on 12 GHz section of Intelsat V)

CHANNELS (IVA)

1	2	3	4	5	6	7	8	9	10	11	12
3725	3765	3805	3845	3885	3925	3975	4015	4055	4095	4135	4175
H/S	S/G	H/S	S/G	H/S	G	H/S	G	H/S	G	H/S	G
R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.

Channels are 36 MHz wide

HALF-TRANSPONDER FREQUENCIES (IVA)

1	2	3	4	5	6	7	8	9	10	11	12
3715.75	3755.75	3795.75	3835.75	3875.75	3915.75	3965.75	4005.75	4045.75	4085.75	4125.75	4165.75
3734.25	3774.25	3814.25	3854.25	3894.25	3934.25	3984.25	4024.25	4064.25	4104.25	4144.25	4184.25

Channels are 17.5 MHz wide
BEAM PATTERN AND POLARIZATION REMAIN THE SAME AS FULL-TRANSPONDER USAGE

60° east (Cont'd)

CHANNELS (V)

1	2	3	4	5	6	7	8	9	10	11	12
3742.5	3742.5	3825	3825	3905	3905	3995	3995	4055	4095	4135	4177.5
H	Z	H	Z	H	Z	H/G	Z	H/G	G	G	G
R.H.	L.H.	R.H.	L.H.	R.H.	L.H.	R.H.	L.H.	R.H.	R.H.	R.H.	R.H.

Channels 1 - 6 are 72 MHz wide, 7 and 8 are 77 MHz wide, 9 - 11 are normal 36 MHz wide, 12 is 41 MHz wide

CHANNELS (V)

1	2	3
11099.2	11155	11577.5
S	S	S
V	V	V

Channel 1 is 77 MHz wide, 2 is 72 MHz wide, 3 is 241 MHz wide

	T.V. Transmissions on IVA	Channel	E.I.R.P.
A.	Oman TV	4A (Half-Transponder)	16 - 18
B.	Algerian TV	5A (Half-Transponder)	20 - 22
C.	Nigerian TV	7B (Half-Transponder)	20 - 22

Note Sound for A and B plus 25 MHz on centre frequency.

POSITION 53° east
SATELLITES Gorizont 3 and Gorizont 5
POLARIZATION Circular

CHANNELS

1	2	3	4	5	6
3675	3725	3775	3825	3875	3925
S/G	Z/G	H	Z/G	H	Z/G
R.H.	R.H.	R.H.	R.H.	R.H.	R.H.

Channels are 40 MHz wide

T.V. Transmissions	Channel	E.I.R.P.
A. Russian TV (1)	1	22 - 24
B. Russian TV (2)	5	30 - 32

POSITION 35° east
SATELLITES Raduga 3, Raduga 6, Raduga 9
POLARIZATION Circular

CHANNELS

1	2	3	4	5	6
3675	3725	3775	3825	3875	3925
S/G	Z/G	H	Z/G	H	Z/G
R.H.	R.H.	R.H.	R.H.	R.H.	R.H.

Channels are 40 MHz wide

T.V. Transmissions	Channel	E.I.R.P.
Russian TV	5	28 - 32

POSITION 19° east
SATELLITE Arabsat 1
POLARIZATION Circular

CHANNELS

Frequency details not available yet, but will have 25 channels in the 4 GHz band with right-hand circular polarization.

T.V. Transmissions	Channel	E.I.R.P.
No precise details at present time, but it is known that a number of the Arab countries will be transmitting on this satellite		Estimated 20 - 24

Note This satellite is due for launch in early to mid 1984.

POSITION 13° east
SATELLITE ECS 2
POLARIZATION Linear

CHANNELS

1	2	3	4	5	6	7	8	9	10	11	12
10991.6	10991.6	11075	11075	11158.3	11158.3	11491.6	11491.6	11575	11575	11658.3	11658.3
EB/S	EB/S	S	S	EB/S	EB/S	S	S	S	S	S	S
H	V	H	V	H	V	H	V	H	V	H	V

Channels are 72 MHz wide

T.V. Transmissions	Channel	E.I.R.P.
Eurovision Links and the possibility of some DBS for this satellite	Not known at the present time	Estimated 35 - 42

Note This satellite is due to be launched in 1983.

POSITION 10° east
SATELLITE ECS 1
POLARIZATION Linear

CHANNELS

1	2	3	4	5	6	7	8	9	10	11	12
10991.6	10991.6	11075	11075	11158.3	11158.3	11491.6	11491.6	11575	11575	11658.3	11658.3
EB/S	EB/S	S	S	EB/S	EB/S	S	S	S	S	S	S
H	V	H	V	H	V	H	V	H	V	H	V

Channels are 72 MHz wide

T.V. Transmissions	Channel	E.I.R.P.
Not known at present time		Estimated 35 - 42

Note This satellite is due for launch in 1983.

POSITION 5° east
SATELLITE OTS 2
POLARIZATION Linear

CHANNELS

1	2	3	4
11510	11510	11640	11640
CONT	CONT	CONT	CONT
V	H	V	H

Channels 1 and 2 are 40 MHz wide, 3 and 4 are 120 MHz wide

	T.V. Transmissions	Channel	E.I.R.P.
A.	France (2)	3 (Part channel, 40 MHz)	42 - 46
B.	Satellite Television Ltd	4 (Part channel, 40 MHz)	42 - 46

Note Both channels employ scrambling techniques.

POSITION 1° west
SATELLITE Intelsat IV F2
POLARIZATION Circular

CHANNELS

1	2	3	4	5	6	7	8	9	10	11	12
3725	3765	3805	3845	3885	3925	3975	4015	4055	4095	4135	4175
S/G	S/G	S/G	S/G	S/G	S/G	S/G	S/G	G	G	G	G
R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.

Channels are 36 MHz wide

HALF-TRANSPONDER FREQUENCIES

1	2	3	4	5	6	7	8	9	10	11	12
3715.75	3755.75	3795.75	3835.75	3875.75	3915.75	3965.75	4005.75	4045.75	4085.75	4125.75	4165.75
3734.25	3774.25	3814.25	3854.25	3894.25	3934.25	3984.25	4024.25	4064.25	4104.25	4144.25	4184.25

Channels are 17.5 MHz wide
BEAM PATTERN AND POLARIZATION REMAIN THE SAME AS FULL-TRANSPONDER USAGE

T.V. Transmissions

None known

POSITION 10° west
SATELLITE Telecom 1A
POLARIZATION Circular on 4 GHz band

CHANNELS

1	2	3	4
3760	3885	4015	4140
S	S	S	S
L.H.	L.H.	L.H.	L.H.

Channels are 90 MHz wide

T.V. Transmissions	Channel		E.I.R.P.
A. 4 GHz	Not known at present time	Estimated	26 - 28
B. 12 GHz	Not known at present time	Estimated	44

Note Satellite is due for launch 1983.

POSITION 11.5° west
SATELLITE Symphonie 1 and Symphonie 2
POLARIZATION Circular

CHANNELS

1	2	3	4
3760	3885	4015	4140
S	S	S	S
L.H.	L.H.	L.H.	L.H.

Channels are 90 MHz wide

T.V. Transmissions	Channel	E.I.R.P.
A. France 1	4 (36 MHz wide bandwidth centred at 4170 MHz)	27 - 29
B. French Newsfeeds	3 (36 MHz wide bandwidth width centred at 3980 MHz)	27 - 29
C. German Radio	4105 MHz	

POSITION 14° west
SATELLITE Gorizont 2
POLARIZATION Circular

CHANNELS

1	2	3	4	5	6
3675	3725	3775	3825	3875	3925
S/G	Z/G	H	Z/G	H	Z/G
R.H.	R.H.	R.H.	R.H.	R.H.	R.H.

Channels are 40 MHz wide

T.V. Transmissions	Channel	E.I.R.P.
A. Russian Television	1	38 - 40
B. Internal Russian Feeds	4	31 - 32
C. International Feeds and Cuban Television	5	31 - 32

POSITION 18.5° west
SATELLITES Intelsat IVA F1 and Intelsat V
POLARIZATION Circular (Linear on 12 GHz Section of Intelsat V)

CHANNELS (IVA)

1	2	3	4	5	6	7	8	9	10	11	12
3725	3765	3805	3845	3885	3925	3975	4015	4055	4095	4135	4175
H/S	S/G	H/S	S/G	H/S	G	H/S	G	H/S	G	H/S	G
R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.

Channels are 36 MHz wide

HALF-TRANSPONDER FREQUENCIES (IVA)

	1	2	3	4	5	6	7	8	9	10	11	12
A.	3715.75	3755.75	3795.75	3835.75	3875.75	3915.75	3965.75	4005.75	4045.75	4085.75	4125.75	4165.75
B.	3734.25	3774.25	3814.25	3854.25	3894.25	3934.25	3984.25	4024.25	4064.25	4104.25	4144.25	4184.25

Channels are 17.5 MHz wide
BEAM PATTERN AND POLARIZATION REMAIN THE SAME AS FULL-TRANSPONDER USAGE

18.5° west (Cont'd)

CHANNELS (V)

1	2	3	4	5	6	7	8	9	10	11	12
3742.5	3742.5	3825	3825	3905	3905	3995	3995	4055	4095	4135	4177.5
H	Z	H	Z	H	Z	H/G	Z	H/G	G	G	G
R.H.	L.H.	R.H.	L.H.	R.H.	L.H.	R.H.	L.H.	R.H.	R.H.	R.H.	R.H.

Channels 1 - 6 are 72 MHz wide, 7 and 8 are 77 MHz wide, 9 - 11 are normal 36 MHz wide, 12 is 41 MHz wide

CHANNELS (V)

1	2	3
11099.2	11155	11577.5
S	S	S
V	V	V

Channel 1 is 77 MHz wide, 2 is 72 MHz wide, 3 is 241 MHz wide

T.V. Transmissions on IVA	Channel	E.I.R.P.
Newsfeeds and American sport	12A or 12B (half transponder)	16 - 19

Note The Intelsat V is due to be launched 1983 and will presumably take over from the Intelsat IVA already at this position.

POSITION 21.5° west
SATELLITES Intelsat IVA F2 and Intelsat V
POLARIZATION Circular (Linear on 12 MHz Section of Intelsat V)

CHANNELS (IVA)

1	2	3	4	5	6	7	8	9	10	11	12
3725	3765	3805	3845	3885	3925	3975	4015	4055	4095	4135	4175
H/S	S/G	H/S	S/G	H/S	G	H/S	G	H/S	G	H/S	G
R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.

Channels are 36 MHz wide

HALF-TRANSPONDER FREQUENCIES (IVA)

	1	2	3	4	5	6	7	8	9	10	11	12
A.	3715.75	3755.75	3795.75	3835.75	3875.75	3915.75	3965.75	4005.75	4045.75	4085.75	4125.75	4165.75
B.	3734.25	3774.25	3814.25	3854.25	3894.25	3934.25	3984.25	4024.25	4064.25	4104.25	4144.25	4184.25

Channels are 17.5 MHz wide
BEAM PATTERN AND POLARIZATION REMAIN THE SAME AS FULL-TRANSPONDER USAGE

21.5° west (Cont'd)

CHANNELS (V)

1	2	3	4	5	6	7	8	9	10	11	12
3742.5	3742.5	3825	3825	3905	3905	3995	3995	4055	4095	4135	4177.5
H	Z	H	Z	H	Z	H/G	Z	H/G	G	G	G
R.H.	L.H.	R.H.	L.H.	R.H.	L.H.	R.H.	L.H.	R.H.	R.H.	R.H.	R.H.

Channels 1 - 6 are 72 MHz wide, 7 and 8 are 77 MHz wide, 9 - 11 are normal 36 MHz wide, 12 is 41 MHz wide

CHANNELS (V)

1	2	3
11099.2	11155	11577.5
S	S	S
V	V	V

Channel 1 is 77 MHz wide, 2 is 72 MHz wide, 3 is 241 MHz wide

T.V. Transmissions on IVA	Channel	E.I.R.P.
A. Saudi Arabian TV	1	20 - 24
B. Niger	3A (half transponder)	18 - 20
C. Sudan	7A (half transponder)	20 - 22
D. Zaire	9A (half transponder)	18 - 20
E. Brazil	6A or 6B (half transponder)	18 - 22

Note The Intelsat V satellite is due to be launched 1983 and will probably replace the Intelsat IVA at this position.

Sound for A at 3900 MHz
South for B, C and D plus 25 MHz on centre frequency

POSITION 24.5° west
SATELLITE Intelsat V F3
POLARIZATION Circular (Linear on 12 MHz Section)

CHANNELS

1	2	3	4	5	6	7	8	9	10	11	12
3742.5	3742.5	3825	3825	3905	3905	3995	3995	4055	4095	4135	4177.5
H	Z	H	Z	H	Z	H/G	Z	H/G	G	G	G
R.H.	L.H.	R.H.	L.H.	R.H.	L.H.	R.H.	L.H.	R.H.	R.H.	R.H.	R.H.

Channels 1 - 6 are 72 MHz wide, 7 and 8 are 77 MHz wide, 9 - 11 are normal 36 MHz wide, 11 is 41 MHz wide

CHANNELS

1	2	3
11099.2	11155	11577.5
S	S	S
V	V	V

Channel 1 is 77 MHz wide, 2 is 72 MHz wide, 3 is 241 MHz wide

HALF-TRANSPONDER FREQUENCIES

	1	2	3	4	5	6	7	8	9	10	11	12
A.	3715.75	3755.75	3795.75	3835.75	3875.75	3915.75	3965.75	4005.75	4045.75	4085.75	4125.75	4165.75
B.	3734.25	3774.25	3814.25	3854.25	3894.25	3934.25	3984.25	4024.25	4064.25	4104.25	4144.25	4184.25

Channels are 17.5 MHz wide
BEAM PATTERN AND POLARIZATION REMAIN THE SAME AS FULL-TRANSPONDER USAGE

T.V. Transmissions	Channel	E.I.R.P.
A. Newsfeeds	12A or 12B (half transponder)	16 - 19
B. Brazil	11B	NA

POSITION 27.5° west
SATELLITE Intelsat V F2
POLARIZATION Circular (Linear on 12 MHz Section)

CHANNELS

1	2	3	4	5	6	7	8	9	10	11	12
3742.5	3742.5	3825	3825	3905	3905	3995	3995	4055	4095	4135	4177.5
H	Z	H	Z	H	Z	H/G	Z	H/G	G	G	G
R.H.	L.H.	R.H.	L.H.	R.H.	L.H.	R.H.	L.H.	R.H.	R.H.	R.H.	R.H.

Channels 1 - 6 are 72 MHz wide, 7 and 8 are 77 MHz wide, 9 - 11 are normal 36 MHz wide, 12 is 41 MHz wide

CHANNELS

1	2	3
11099.2	11155	11577.5
S	S	S
V	V	V

Channel 1 is 77 MHz wide, 2 is 72 MHz wide, 3 is 241 MHz wide

HALF-TRANSPONDER FREQUENCIES

	1	2	3	4	5	6	7	8	9	10	11	12
A.	3715.75	3755.75	3795.75	3835.75	3875.75	3915.75	3965.75	4005.75	4045.75	4085.75	4125.75	4165.75
B.	3734.25	3774.25	3814.25	3854.25	3894.25	3934.25	3984.25	4024.25	4064.25	4104.25	4144.25	4184.25

Channels are 17.5 MHz wide
BEAM PATTERN AND POLARIZATION REMAIN THE SAME AS FULL-TRANSPONDER USAGE

T.V. Transmissions	Channel	E.I.R.P.
A. Morocco	3A (half transponder)	22 - 24
B. Argentina	12	22 - 24

Note Sound for A plus 25 MHz on centre frequency.

POSITION 30° west
SATELLITE Intelsat V
POLARIZATION Circular (Linear on 12 MHz Section)

CHANNELS

1	2	3	4	5	6	7	8	9	10	11	12
3742.5	3742.5	3825	3825	3905	3905	3995	3995	4055	4095	4135	4177.5
H	Z	H	Z	H	Z	H/G	Z	H/G	G	G	G
R.H.	L.H.	R.H.	L.H.	R.H.	L.H.	R.H.	L.H.	R.H.	R.H.	R.H.	R.H.

Channels 1 - 6 are 72 MHz wide, 7 and 8 are 77 MHz wide, 9 - 11 are normal 36 MHz wide, 12 is 41 MHz wide

CHANNELS

1	2	3
11099.2	11155	11577.5
S	S	S
V	V	V

Channel 1 is 77 MHz wide, 2 is 72 MHz wide, 3 is 241 MHz wide

HALF-TRANSPONDER FREQUENCIES

	1	2	3	4	5	6	7	8	9	10	11	12
A.	3715.75	3755.75	3795.75	3835.75	3875.75	3915.75	3965.75	4005.75	4045.75	4085.75	4125.75	4165.75
B.	3734.25	3774.25	3814.25	3854.25	3894.25	3934.25	3984.25	4024.25	4064.25	4104.25	4144.25	4184.25

Channels are 17.5 MHz wide
BEAM PATTERN AND POLARIZATION REMAIN THE SAME AS FULL-TRANSPONDER USAGE

Note This satellite is due to be launched in 1983.

POSITION 34.5° west
SATELLITES Intelsat IVA F4 and Intelsat V F5
POLARIZATION Circular (Linear on 12 MHz Section)

CHANNELS (IVA)

1	2	3	4	5	6	7	8	9	10	11	12
3725	3765	3805	3845	3885	3925	3975	4015	4055	4095	4135	4175
H/S	S/G	H/S	S/G	H/S	G	H/S	G	H/S	G	H/S	G
R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.

Channels are 36 MHz wide

HALF-TRANSPONDER FREQUENCIES (IVA)

	1	2	3	4	5	6	7	8	9	10	11	12
A.	3715.75	3755.75	3795.75	3835.75	3875.75	3915.75	3965.75	4005.75	4045.75	4085.75	4125.75	4165.75
B.	3734.25	3774.25	3814.25	3854.25	3894.25	3934.25	3984.25	4024.25	4064.25	4104.25	4144.25	4184.25

Channels are 17.5 MHz wide
BEAM PATTERN AND POLARIZATION REMAIN THE SAME AS FULL-TRANSPONDER USAGE

34.5° west (Cont'd)

CHANNELS (V)

1	2	3	4	5	6	7	8	9	10	11	12
3742.5	3742.5	3825	3825	3905	3905	3995	3995	4055	4095	4135	4177.5
H	Z	H	Z	H	Z	H/G	Z	H/G	G	G	G
R.H.	L.H.	R.H.	L.H.	R.H.	L.H.	R.H.	L.H.	R.H.	R.H.	R.H.	R.H.

Channels 1 - 6 are 72 MHz wide, 7 and 8 are 77 MHz wide, 9 - 11 are normal 36 MHz wide, 12 is 41 MHz wide

CHANNELS (V)

1	2	3
11099.2	11155	11577.5
S	S	S
V	V	V

Channel 1 is 77 MHz wide, 2 is 72 MHz wide, 3 is 241 MHz wide

T.V. Transmissions on IVA	Channel	E.I.R.P.
A. International Newsfeeds	12A or 12B (half transponder)	16 - 19
B. Spanish	7B (half transponder)	18 - 22

POSITION 53° west
SATELLITE Intelsat IV F7
POLARIZATION Circular

CHANNELS

1	2	3	4	5	6	7	8	9	10	11	12
3725	3765	3805	3845	3885	3925	3975	4015	4055	4095	4135	4175
S/G	S/G	S/G	S/G	S/G	S/G	S/G	S/G	S/G	G	G	G
R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.	R.H.

Channels are 36 MHz wide

HALF-TRANSPONDER FREQUENCIES

	1	2	3	4	5	6	7	8	9	10	11	12
A.	3715.75	3755.75	3795.75	3835.75	3875.75	3915.75	3965.75	4005.75	4045.75	4085.75	4125.75	4165.75
B.	3734.25	3774.25	3814.25	3854.25	3894.25	3934.25	3984.25	4024.25	4064.25	4104.25	4144.25	4184.25

Channels are 17.5 MHz wide
BEAM PATTERN AND POLARIZATION REMAIN THE SAME AS FULL-TRANSPONDER USAGE

POSITION 66° west
SATELLITE Satcom F7
POLARIZATION Linear

CHANNELS

1	2	3	4	5	6	7	8	9	10	11	12
3720	3740	3760	3780	3800	3820	3840	3860	3880	3900	3920	3940
CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT
V	H	V	H	V	H	V	H	V	H	V	H

1	2	3	4	5	6	7	8	9	10	11	12
3960	3980	4000	4020	4040	4060	4080	4100	4120	4140	4160	4180
CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT
V	H	V	H	V	H	V	H	V	H	V	H

Channels are 36 MHz wide

T.V. Transmissions	Channel	E.I.R.P.
To be expected on this satellite		18 - 22 (estimated)

Note This satellite is due to be launched in 1983.

POSITION 70° west (Provisional)
SATELLITE Brazilsat I
POLARIZATION Horizontal

CHANNELS

1	2	3	4	5	6	7	8	9	10	11	12
3720	3740	3760	3780	3800	3820	3840	3860	3880	3900	3920	3940
CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT
V	H	V	H	V	H	V	H	V	H	V	H

1	2	3	4	5	6	7	8	9	10	11	12
3960	3980	4000	4020	4040	4060	4080	4100	4120	4140	4160	4180
CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT
V	H	V	H	V	H	V	H	V	H	V	H

Channels are 36 MHz wide

T.V. Transmissions Channel E.I.R.P.

To be expected on this satellite

Note This satellite is due to be launched in 1985.

POSITION 70° west (Provisional)
SATELLITE Spacenet 2
POLARIZATION Linear

CHANNELS

1	2	3	4	5	6	7	8	9	10	11	12
3720	3740	3760	3780	3800	3820	3840	3860	3880	3900	3920	3940
CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT
V	H	V	H	V	H	V	H	V	H	V	H

1	2	3	4	5	6	7	8	9	10	11	12
3960	3980	4000	4020	4040	4060	4080	4100	4120	4140	4160	4180
CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT
V	H	V	H	V	H	V	H	V	H	V	H

Channels are 36 MHz wide

T.V. Transmissions	Channel	E.I.R.P.
To be expected on this satellite		18 - 22 (estimated)

Note This satellite is due to be launched in 1984.

POSITION 70° west (Provisional)
SATELLITE Satcol 2
POLARIZATION Linear

CHANNELS

1	2	3	4	5	6	7	8	9	10	11	12
3720	3740	3760	3780	3800	3820	3840	3860	3880	3900	3920	3940
CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT
V	H	V	H	V	H	V	H	V	H	V	H

1	2	3	4	5	6	7	8	9	10	11	12
3960	3980	4000	4020	4040	4060	4080	4100	4120	4140	4160	4180
CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT
V	H	V	H	V	H	V	H	V	H	V	H

Channels are 36 MHz wide

T.V. Transmissions Channel E.I.R.P.

To be expected on this satellite

Note This satellite is due to be launched in 1984.

POSITION 74° west
SATELLITE Galaxy 2
POLARIZATION Linear

CHANNELS

1	2	3	4	5	6	7	8	9	10	11	12
3720	3740	3760	3780	3800	3820	3840	3860	3880	3900	3920	3940
CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT
V	H	V	H	V	H	V	H	V	H	V	H

1	2	3	4	5	6	7	8	9	10	11	12
3960	3980	4000	4020	4040	4060	4080	4100	4120	4140	4160	4180
CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT
V	H	V	H	V	H	V	H	V	H	V	H

Channels are 36 MHz wide

T.V. Transmissions — Channel — E.I.R.P.

To be expected on this satellite — 18 - 24 (estimated)

Note This satellite is due to be launched in 1983.

POSITION 75.5° west
SATELLITE Satcol 1
POLARIZATION Linear

CHANNELS

1	2	3	4	5	6	7	8	9	10	11	12
3720	3740	3760	3780	3800	3820	3840	3860	3880	3900	3920	3940
CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT
V	H	V	H	V	H	V	H	V	H	V	H

1	2	3	4	5	6	7	8	9	10	11	12
3960	3980	4000	4020	4040	4060	4080	4100	4120	4140	4160	4180
CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT
V	H	V	H	V	H	V	H	V	H	V	H

Channels are 36 MHz wide

T.V. Transmissions — Channel — E.I.R.P.

To be expected on this satellite

Note This satellite is due to be launched in 1984.

POSITION 79° west
SATELLITE Westar I
POLARIZATION Linear

CHANNELS

1	2	3	4	5	6	7	8	9	10	11	12
3720	3760	3800	3840	3880	3920	3960	4000	4040	4080	4120	4160
CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT
V	H	V	H	V	H	V	H	V	H	V	H

Channels are 36 MHz wide

T.V. Transmissions	Channel	E.I.R.P.
A. American Sport, News and Network Feeds	2	18 - 22 (estimated)
B. Fuse Television Network and Sports	5	18 - 22 (estimated)
C. American Sport, News and Network Feeds	12	18 - 22 (estimated)

POSITION 83° west
SATELLITE Satcom F4
POLARIZATION Linear

CHANNELS

1	2	3	4	5	6	7	8	9	10	11	12
3720	3740	3760	3780	3800	3820	3840	3860	3880	3900	3920	3940
CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT
V	H	V	H	V	H	V	H	V	H	V	H

1	2	3	4	5	6	7	8	9	10	11	12
3960	3980	4000	4020	4040	4060	4080	4100	4120	4140	4160	4180
CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT	CONT
V	H	V	H	V	H	V	H	V	H	V	H

Channels are 36 MHz wide

	T.V. Transmissions	Channel	E.I.R.P.
A.	Bravo Television (Cultural Arts)	6	20 - 23 (estimated)
B.	National Christian Network (Religion)	7	20 - 22 (estimated)
C.	The Entertainment Channel	8	20 - 22 (estimated)
D.	Occasional Network Feeds	11	20 - 22 (estimated)
E.	Trinity Broadcasting Network (Religion)	17	20 - 22 (estimated)
F.	Occasional Feeds	18	20 - 22 (estimated)
G.	American Network Movies (First run films)	19	20 - 22 (estimated)
H.	Occasional Feeds	23	20 - 22 (estimated)
I.	NBC Network Remote Feeds	24	20 - 22 (estimated)
J.	Family Radio Network (2 channels in stereo)	7	

CHAPTER 10

RECEPTION TECHNIQUES

In order to receive the maximum number of channels, and the best reception possible, it is necessary to consider a number of factors relevant to the signal output from the satellite and the site of the receiver. By taking advantage of the following information it will be possible to gain a better understanding of reception situations from different satellites.

Satellite View Angle and Noise Temperature

When viewing the satellite orbit belt from the earth, it can be seen that as satellites move further away from the local meridian that they become progressively lower relevant to the horizon.

Most of Europe has a view of the satellite belt over a sweep of 150°. By reference to the preceding chapter, it can be seen that a large number of satellites are in view, and the possibility of reception from individual satellites can be calculated by using the formula for aiming the aerial.

For those satellites towards the end of the viewable belt, one starts getting very low viewing angles, and the problem that occurs in this situation is an increase in the noise temperature of the aerial.

As an estimation, at 30° viewing angle, a 10 foot diameter the antenna would have an approximate temperature of 35°K, at 20° viewing angle, it would have a noise temperature of 40°K, at 10° viewing angle it would have a noise temperature of 60°K, and at 5° viewing angle it would have a noise temperature of 80°K. These figures are only an approximation, and can vary plus or minus 10°K. A way of improving the situation when working at very low viewing angles, is to shroud the periphery of the antenna, as this can give a reduction in noise temperature in the region of 30°K.

Beam Patterns and E.I.R.P.

Most of the satellites which are in orbit are capable of transmitting a different number of beam patterns to the earth. The variations of these patterns are as follows:-

BEAM PATTERN	AREA COVERED
Global	Whole area of earth in view from satellite.
Hemispheric	Shaped beam. Approx ½ global beam in area.
Zone	Approx ½ hemispheric beam.
Eurobeam) Continental)	Shaped beam to cover major land mass.
Spot	Concentrated local area within continent.

As can be appreciated, the smaller an area that the transponder on the satellite is illuminating with its signal, the higher is the EIRP of the signal within the area being illuminated.

The following are broad estimates of the EIRP strength for the different types of beams on the major satellites in view from Europe.

	BEAM	E.I.R.P. RANGE (estimated)
INTELSAT IV	Global	22 - 25 dB
	Spot	20 - 36 dB
INTELSAT IVA	Global	22 - 25 dB
	Hemispheric	22 - 29 dB
	Spot	20 - 36 dB
INTELSAT V	Global	24 - 26 dB
	Hemispheric	26 - 30 dB
	Zone	29 - 36 dB
GORIZONT	Global	26 - 28 dB
	Hemispheric	20 - 31 dB
	Zone	30 - 37 dB
	Spot	30 - 46 dB
RADUGA	Global	26 - 28 dB
	Hemispheric	20 - 31 dB
SYMPHONIE	Spot	29 - 32 dB

It must be emphasised that the EIRPs as stated are the maximum that is available from the satellite. In reality, the controllers of the satellites reduce the power output level by anything between 2dB and 8dB.

In the case where television transmissions are broadcast on a half transponder, it is also necessary to reduce the EIRP in order to avoid interference with the signal on the other half of the transponder. When reduced capacity is acceptable on this other half, an increase in EIRP can be implemented.

Half Transponder T.V. Transmissions

In the early usage of Intelsat satellites for television transmissions it was normal to use a full 36 MHz wide transponder, in order to give the best quality video possible.

As the transmission of television via satellites became more popular, Intelsat eventually standardised on a half transponder format. Therefore, in each transponder it is possible to fit two television channels with a 1 MHz guardband separating them, therefore each channel would be 17.5 MHz wide.

In order to control interference between the two carriers, it was necessary to reduce the EIRP by approximately 4 dB.

The sound accompanying the transmissions is normally on a subcarrier, varying between 5.8 MHz and 6.65 MHz. In the instances where this is not the case, it has been noted in the relevant data in Chapter 9.

It has been found possible to increase the output power of a half transponder lease, by up to 6 dB, as a result of increasing the deviation applied to the video signal, although this does result in the loss of some capacity on the other half of the transponder.

Users of this form of improved power output are Niger, Sudan, Zaire, Morocco, Oman and Algeria.

Broadcast Standards

All satellite television transmissions are either 525 lines at 60 fields per second, which is the standard used in the USA and parts of South America, or 625 lines at 50 fields per second, which is the European Russian and African standard.

If you are attempting to receive a 525 line signal on a 625 line television, you will find that the picture does not fill the screen.

By adjustment to the framehold and the height control, it will be possible to resolve a reasonably balanced picture.

The following is a list of countries which are transmitting on satellite, and the relevant standards on which the television is transmitted

COUNTRY	LINES/FIELDS	COLOUR SYSTEM
Algeria	625/50	PAL
Argentina	625/50	PAL
Brazil	525/60	PAL
Cuba	525/60	NTSC
France	625/50	SECAM
Italy	625/50	PAL
Morocco	625/50	SECAM
Niger	625/50	SECAM
Nigeria	625/50	PAL
Oman	625/50	PAL
Saudi Arabia	625/50	SECAM
Spain	625/50	PAL
Sudan	625/50	PAL
U.S.A.	525/60	NTSC
U.S.S.R.	625/50	SECAM
Zaire	625/50	SECAM

Nowadays, the vast majority of television is transmitted in colour, and as can be noted from the foregoing list, there are three systems in use, these being PAL, NTSC and SECAM.

As is normal with industrial standards, there is no compatibility whatsoever between the three colour systems. What this basically means is that a colour television which is manufactured to resolve PAL system colour, will only show an NTSC or SECAM colour picture in black and white.

It is possible to purchase multi-standard televisions that will handle the three major world systems, but they are fairly expensive, and rather difficult to get hold of. It is rumoured that a decoder/encoder module is being developed in the United States at the present time, which will enable a PAL receiver to resolve full colour pictures which are transmitted in NTSC.

Intelsat International Feeds

The three Intelsat satellites, which are based at 18.5° west 24.5° west and 34.5° west, are used to transmit many news and sports programmes from points in Europe to the United States and vice versa.

The major satellite carrying these transmissions is at 24.5° west, and is in operation from mid-morning until late at night, carrying news service

feeds from London, Paris, Rome, Lisbon, Madrid and Brussels to the United States. All three colour systems are used on these transmissions, and they make very interesting viewing.

On the Intelsat at 18.5° west, is the main Eurovision European News Exchange and news feeds from London to the U.S.A.

Also, on weekends, there are some sports feeds from the United States of America to Europe.

On the Intelsat at 34.5° west is the UPITN News Service from New York, which supplies news service around the world, and on Saturday evenings sports feeds from the United States to Europe.

CHAPTER 11

DIRECT BROADCAST SERVICE (DBS) TELEVISION

Whilst this book has concentrated on television reception from satellites on the 4 GHz band, many nations intend to implement direct broadcast services (DBS) television in Europe on the 12 GHz band over the next 5 years. Whilst in concept, it is virtually the same as the system that has been outlined so far in this book, there a number of detailed differences.

The DBS System

As is implied in its name, the DBS Television System is designed for broadcast direct into individual homes, as opposed to the 4 GHz system, which is primarily intended to be for transmission from one supplier of television to another.

All the nations in Europe have been allocated channels for a DBS service, and whilst a number of them have stated their intentions of having their own individual satellite, undoubtedly the situation will come about where some nations will share a satellite in order to implement their services.

It is to be hoped that an international influence will also occur on the DBS transmissions, as it will provide for a large majority of the population of Europe as the only alternative to terestrial television.

Although we have heard lately much news about the implementation of cable television, the best prognosis that anyone can give is that in the United Kingdom only 30% of the population will be on cable, and that 30% will be almost totally the population living in the major urban areas. In Europe the figures given for people on cable are higher, but nevertheless, a large segment of the total European population will never have cable television.

DBS Equipment

The basic equipment that will be required for the reception of DBS television is identical in format to that used on the 4 GHz band. That is, a parabolic dish, an LNA and down converter, or an LNC and a receiver.

The parabolic antenna that will be needed will be considerably smaller in size than that used on the 4 GHz band. For reception in the centre area of a spot beam, it will be possible to use dishes as small as 18 in. in diameter. This is partly due to the higher power outputs from the DBS satellites, and partly to the fact that the higher the frequency becomes the higher the gain a parabolic antenna delivers.

The LNA section of a DBS system can have a much higher noise level than the units that are used at 4 GHz, again due to the higher power output from the satellite.

The down converters will need to be more sophisticated than those used at the present time, since working at a frequency three times higher, they will be subject to much more sensitivity with regard to temperature and, therefore, it is realistic to expect that the use of custom designed integrated circuits will come about.

It has already been stated that some of the suppliers of television on DBS will employ scrambling techniques. This is mostly due to governmental narrow mindedness in not wanting their population to view television output by another country. The other reason for scrambling will be when the television programme is supplied on a pay-as-you-watch basis.

Since these programmes will be scrambled, it will be necessary to have additional electronics at the receiver end to unscramble the picture, and this of course will add to the complexity and cost of the individual units installed in the home.

DBS Timescale

At the present moment, there is one interim design semi-DBS satellite in orbit. This is the French OTS, which carries the France II TV channel and Satellite TV Limited programming. It is intended in 1983 to orbit ECS I and ECS II, both of which are capable of providing a number of channels of DBS television into Europe, based on the 10.95 GHz to 11.7 GHz band.

The first true DBS dedicated satellites are due for launch in 1985 onwards.

The first to be launched will be TVsat in 1985, which will carry three channels of German television. Following on from that there will be TDF I in 1986 with three channels of French television, Lsat in 1986/87 with two DBS channels, satellite Haley in 1986 with five channels of British television, Luxsat in 1987 for Luxembourg television, Telsat in 1987 for Swiss television and Tele X in 1987 for Swedish television. All of these satellites will be transmitting in the 11.7 GHz to 12.5 GHz band.

Power Levels

The DBS satellites will almost exclusively use spot beams, but these will be viewable all over Europe using only a slightly larger dish than that required for the satellite dedicated to the country that one lives in. On a realistic level, a three foot dish should be capable of receiving all of the above mentioned satellites.

Due to the varying positions in the orbit that these satellites will occupy, it will of course be necessary to have a steerable parabolic antenna.

EIRP levels to be expected on the interim units will be in the level of 35 to 44 dB, and on the later dedicated units it is to be expected that levels in the realms of 56 to 66 dB will be found. With these levels of power it can be easily seen that good reception can be expected all over Europe, and that the overlap of signal should run well out towards the Middle East and down into Africa.

1	**NICKELODEON** 13 hours of programing daily designed for preschool through teenage audiences. Commercial-free, featuring non-violent, pro-social programing.	Daily, 8 am-9 pm
1	**ARTS** (Alpha Repertory Television Service) Presentation of performing, visual and lively arts designed to meet the special programing needs of viewers interested in the fine arts.	Daily, 9 pm-Midnight
2	**PTL** (Praise The Lord) Only full-time non-commercial Christian network reaching all 50 states. Interdenominational programing includes talk/variety, children's, drama, music and specials for the entire family.	Daily, 24 hours
3	**WGN** Well-rounded programing format featuring movies, sports, specials and syndicated programs. From Chicago's leading independent television station (WGN-TV, Chicago, Channel 9).	Daily, 24 hours
4	**SPOTLIGHT** Pay television service featuring major motion pictures, film festivals, children's fare and some foreign and classic films. Spotlight schedules a different feature every night of the month in prime-time along with a fixed start time for its 8 p.m. (ET) film.	Daily, 24 hours
5	**THE MOVIE CHANNEL** The 24-hour, all-movie, commercial-free channel.	Daily, 24 hours
6	**WTBS** Cable-oriented independent station. Family directed programs—sports, movies, quality syndication, national/international news, unique "Superstation" programing.	Daily, 24 hours
7	**ESPN** Men's and women's professional college and amateur sporting events including college football and basketball, NBA basketball, USFL football, WCT and Davis Cup tennis, top rank boxing, CFL football and NASCAR and CART auto racing.	Daily, 24 hours
8	**CBN CABLE NETWORK, The Family Entertainer** Family cable programing with a wide range of upbeat entertainment for all ages. Women's programs, a daily TV magazine, a continuing drama, documentaries, great westerns, exciting movie packages, TV comedy classics, inspirational Christian shows and more.	Daily, 24 hours
9	**USA CABLE NETWORK** Features broad-based, special-interest programs, including sports (more than 500 events annually); children's (Calliope and Scholastic Sports Academy); USA Daytime (women's programing daily); documentary/entertainment (English Channel, Night Flight).	Daily, 24 hours
10	**SHOWTIME (West)** Showtime offers innovative entertainment 24 hours-a-day, including blockbuster movies, original series, and serials, comedy, Broadway theater, concert performances with big name stars, foreign and classic films, children's programing and late night adult entertainment.	Daily, 24 hours
11	**MTV** (Music Television) The first 24-hour, advertiser-supported, video rock 'n' roll channel.	Daily, 24 hours
12	**SHOWTIME (East)** Same as Showtime transponder 10.	Daily, 24 hours
13	**HBO (West)** The industry's most popular full-service complement of first run movies, sports and entertainment specials.	Daily, 24 hours
14	**CNN** (Cable News Network) Live news format with round-the-clock news coverage developed specifically for the cable viewer. Headlines, in-depth reporting, hard news, sports, weather, features and financial reports; news when the viewer wants it.	Daily, 24 hours
15	**CNN HEADLINE NEWS** Continuously updated 30-minute wheel of hard news with a six-minute window for cable systems to insert local news. Compact hard news headline service catered to the person who wants a quick fix of the news.	Daily, 24 hours
16	**HTN PLUS** Expanded family entertainment featuring 12 hours daily of PG/G movies concerts and specials, and travel programing.	Daily, 4 pm-4 am
16	**ACSN-THE LEARNING CHANNEL** Valuable and enjoyable learning programs for adults including career-oriented programs, new leisure-time activities, personal skills and interpersonal relationships. College credit courses.	Mon-Fri 6 am-4 pm Sat&Sun 6 am-1 pm
16	**NJT** (National Jewish Television) Programing of interest to Jewish viewers ranging from current affairs to entertainment to religious topics.	Sun 1 pm-4 pm
17	**CABLE HEALTH NETWORK** Advertiser-supported network devoted to health, science and better living.	Daily, 24 hours
18	**REUTERS MONITOR SERVICE** Encoded data text retrieval service.	Mon-Fri 4 am-8 pm
18	**EWTN** (Eternal Word Television Network) EWTN's emphasis is on Catholic spiritual growth programming with a balance of family entertainment including feature movies, music programs and children's shows. The network does not solicit funds on the air.	Daily 8 pm-12 pm
19	**C-SPAN** Daily live coverage of the House of Representatives, Congressional & Senate hearings, National Press Club luncheons, CloseUp high school government series. Two live daily call-in shows and other public affairs seminars, conferences and conventions.	Daily, 24 hours

Channel allocation on Satcom F3 (131°w)

9 Sports Look
10 Gold Bug
13 Video Jukebox
14 Sports Today

8:00E 7:00C 6:00M 5:00P

1 Livewire
2 Camp Meeting USA
3 TBA
4 MOVIE: 'On the Right Track'
6 MOVIE: 'Land Raiders' A ruthless townsman in the Arizona Territory buys the scalps of murdered Indians. Telly Savalas, George Maharis, Arlene Dahl. 1969.
7 NCAA Football: Rutgers @ Pittsburgh
8 I Spy
9 USA Presents
12 MOVIE: 'The Postman Always Rings Twice'
13 Two of Hearts
14 Prime News
15 News Update
17 Cable Health World Report
18 Villa Alegre [Closed Captioned]
20 MOVIE: 'The V.I.P.'s'
22 24 MOVIE: 'The Howling'
23 Hunted in Holland

8:30E 7:30C 6:30M 5:30P

10 Great Ladies of Country 2
17 Reader's Digest
18 Gigglesnort Hotel

9:00E 8:00C 7:00M 6:00P

1 Long Day's Journey Into Night Eugene O'Neills drama depicting the love, hate and passionate conflicts of a family in the early 1900's.
2 Jim Bakker
8 700 Club
9 NHL Hockey: Montreal at St. Louis
11 Video Music
13 Bushmen of the Kalahari
17 Philbin's Health Styles
18 Searching
19 Call-In Program
23 MOVIE: 'Drowning Pool'

9:30E 8:30C 7:30M 6:30P

5 MOVIE: 'Enter the Ninja'
10 Ernie Kovac: Television's Original Genius
18 Let's Face It
22 24 MOVIE: 'Foolin' Around'

10:00E 9:00C 8:00M 7:00P

2 Oral Roberts
4 MOVIE: 'The Survivor'
6 TBS Evening News
12 A New Day in Eden 7
13 HBO Magazine
14 Freeman Reports
16 MOVIE: 'Stripes'
17 Crisis Counselor
18 Life Is Worth Living
19 Agency Hearing or Debates
20 MOVIE: 'Lipstick'

10:30E 9:30C 8:30M 7:30P

2 Revival Fires
8 Star Time
12 Test of Love 5
17 Special Presentation
18 Discovery

11:00E 10:00C 9:00M 8:00P

2 Good News America
3 News
6 All In the Family
7 SportsCenter
10 MOVIE: 'The Postman Always Rings Twice'
12 Bizarre 5
13 MOVIE: 'The Howling'
14 Sports Tonight
15 News Update
17 Human Sexuality
18 Sacred Heart
23 MOVIE: 'The V.I.P.'s'

11:15E 10:15C 9:15M 8:15P

18 Answer/Love

11:30E 10:30C 9:30M 8:30P

2 The King Is Coming
4 MOVIE: 'Return of the Dragon'
5 MOVIE: 'Rich and Famous'
6 MOVIE: 'Kiss of Death' A captured jewel thief refuses to aid an assistant D.A. to lighten his sentence until he learns that his cohorts kept all of the loot, giving none to his family. Brian Donlevy, Victor Mature, Richard Widmark. 1947
8 Another Life
12 MOVIE: 'So Fine'
14 Crossfire
17 The Nature of Things
18 Westbrook Hospital
20 MOVIE: 'Body and Soul'
22 24 MOVIE: 'The Wild Geese'

12:00E 11:00C 10:00M 9:00P

2 Jim Bakker
3 Twilight Zone
7 NCAA Football: Washington @ Washington St.
8 Burns & Allen
9 Sports Probe
11 Video Music
14 Newsnight
16 Marvin Hamlisch in Concert
17 Cable Health World Report

12:30E 11:30C 10:30M 9:30P

3 MOVIE: 'Anastasia' A girl, after spending two years in an asylum, declares she is Anastasia Romanov, sole surviving heir of Czar Nickolai II. Lilli Palmer, Ivan Desny. 1956.
8 Jack Benny Show
9 NHL Hockey: Montreal at St. Louis
13 MOVIE: 'Foolin' Around'
14 Moneyline Update
17 Reader's Digest

1:00E 12:00C 11:00M 10:00P

2 Westbrook Hospital
4 MOVIE: 'The Final Conflict'
8 I Married Joan
10 A New Day in Eden 7
12 MOVIE: 'Ghost Story'
14 Mike Douglas People Now
16 1982 NFL Specials
17 Philbin's Health Styles
23 MOVIE: 'Lipstick'

1:30E 12:30C 11:30M 10:30P

5 MOVIE: 'First Family'
6 MOVIE: 'The Wild Heart' A Welsh girl's only guide to her wild emotions is an old book of legends. Jennifer Jones, Hugh Griffith, David Farrar. 1952
8 My Little Margie
10 Test of Love 5
20 MOVIE: 'Drowning Pool'

1:45E 12:45C 11:45M 10:45P

22 24 MOVIE: 'The Formula'

2:00E 1:00C 12:00M 11:00P

2 Jim Bakker
8 Bachelor Father
10 Bizarre 5
12 Sports Update
13 News Update
16 MOVIE: 'Stripes'
17 The Charlie Rose Show
19 Call-In Program

2:30E 1:30C 12:30M 11:30P

7 SportsCenter
8 Life of Riley
10 MOVIE: 'So Fine'
13 MOVIE: 'The Wild Geese'
14 Crossfire
17 Human Sexuality
23 MOVIE: 'Body and Soul'

3:00E 2:00C 1:00M 12:00P

2 Good News
3 Nightbeat
4 MOVIE: 'Three Days of the Condor'
8 700 Club
12 Just Before Dawn
14 Prime News
17 Crisis Counselor
19 Congressional Hearing

3:15E 2:15C 1:15M 12:15P

6 MOVIE: 'The Fabulous World Of Jules Verne' Professor and his assistant working on an important experiment, the forerunner of today's atomic energy, are abducted by a band of pirates whose leader hopes to conquer the world with the professor's invention. Lou Tock, Ernie Navara, Milo Hall. 1961
20 MOVIE: 'The Baby Maker'

3:30E 2:30C 1:30M 12:30P

2 Oral Roberts
3 All Night Show
5 MOVIE: 'Just Before the Dawn'
7 This Week in the NBA
9 Sports Probe
17 Cable Health World Report

3:45E 2:45C 1:45M 12:45P

22 24 MOVIE: 'Father Figure'

4:00E 3:00C 2:00M 1:00P

2 Time of Deliverance
3 MOVIE: 'Beauty and the Bandit'
7 CFL Football: Western Division Final
9 NCAA Football: North Carolina State at Miami
10 MOVIE: 'Ghost Story'
17 Special Presentation

4:30E 3:30C 2:30M 1:30P

2 Light and Lively
8 Ross Bagley
12 MOVIE: 'The High Country'
17 Take Charge
23 MOVIE: 'Drowning Pool'

4:45E 3:45C 2:45M 1:45P

13 MOVIE: 'The Formula'

Wednesday

11/24/82

MORNING

5:00E 4:00C 3:00M 2:00P

2 Patterns for Living
4 MOVIE: 'Delusion'
5 MOVIE: 'Southern Comfort'
6 Mission Impossible
13 Sports Review
19 Public Policy Forum

5:15E 4:15C 3:15M 2:15P

20 MOVIE: 'The Intruder'
22 24 HBO Magazine

5:30E 4:30C 3:30M 2:30P

2 Dan Griffin Show
3 Sea Hunt
14 Moneyline

6:00E 5:00C 4:00M 3:00P

2 Krooze Brothers
10 Just Before Dawn
16 American Government

6:15E 5:15C 4:15M 3:15P

23 MOVIE: 'The Baby Maker'

6:30E 5:30C 4:30M 3:30P

2 Rex Humbard
7 SportsForum
9 USA Presents
12 The Shogun Warriors: Starvengers
15 Writing for a Reason
22 24 Raggedy Ann and Andy

6:45E 5:45C 4:45M 3:45P

13 MOVIE: 'Father Figure'

7:00E 6:00C 5:00M 4:00P

4 MOVIE: 'Three Days of the Condor'
5 MOVIE: 'King Solomon's Treasure'
7 SportsForum
8 MOVIE: 'Savage Drums' An educated islander returns home to subdue the invaders who have taken control of his people. Sabu, Lita Baron. 1951.
16 Parents as Partners
20 Sophie Minds the Store

7:30E 6:30C 5:30M 4:30P

10 MOVIE: 'The High Country'
16 Families-Will They Survive
20 Corlette and Son

8:00E 7:00C 6:00M 5:00P

16 Conversation With... A conversation with Lady Bird Johnson.
20 MOVIE: 'Secrets of Three Hungry Wives'
22 24 MOVIE: 'Ode to Billy Joe'

8:15E 7:15C 6:15M 5:15P

13 HBO Magazine
23 MOVIE: 'The Intruder'

8:30E 7:30C 6:30M 5:30P

2 Great Day to Remember
5 MOVIE: 'Prince of the City'
8 MOVIE: 'Last Stagecoach West' The loss of a government mail contract leads to the failure of a stagecoach business. Victor Jory, Jim Davis, Mary Castle. 1957.
12 Showtime's Hollywood
16 Modern Supervisory Tech.

9:00E 8:00C 7:00M 6:00P

4 The New Maid
6 MOVIE: 'Rosie' A wealthy widow, encouraged by her adoring granddaughter, goes from one madcap adventure to another until her daughters decide to take matters into their own hands and have her declared mentally incompetent. Rosalind Russell, Sandra Dee, Brian Aherne, Audrey Meadows. 1967
7 SportsForum
12 Jonathan Winters 'Zsa Zsa Gabor'
16 TBA
19 Look at Elections 82

9:30E 8:30C 7:30M 6:30P

2 Ever Increasing Faith
4 MOVIE: 'Sir Gawain and the Green Knight'
7 This Week in the NBA
10 The Shogun Warriors: Starvengers
12 Aerobicise
13 Raggedy Ann and Andy
16 Sport Fishing

10:00E 9:00C 8:00M 7:00P

3 MOVIE: 'Mississippi Gambler' A riverboat gambler decides to build an honest casino. Tyrone Power, Julie Adams, Ron Randell. 1953.
7 SportsCenter
12 MOVIE: 'Skirts Ahoy'
16 American Enterprise
17 Join the Group

Sample of American Domsat programming.

CHAPTER 12

THE FUTURE OF SATELLITE T.V.

At the present time satellite television that can be received in Europe is comprised of transatlantic feeds, and countries distributing their television programmes internally via satellites.

Whilst the reception of this type of programming is undoubtedly interesting, and in certain instances can be very entertaining, it falls a long way short of being a substitute for the terestrial television systems programming within Europe. However, this situation is due to change within a very short period of time.

American Television

Undoubtedly, if it were possible to receive it, American television would provide a valued increase to the programming available for viewing.

It is almost certain that during 1983 American television will become available from the satellites for reception in Europe.

The first, and probably most available feed to occur will be when the American Forces Network T.V. appears on one of the Intelsat satellites. AFN signed an agreement whereby American television would be made available to American forces based in Europe and the Middle East. It is to be believed that the programming will comprise one of the American major networks, such as ABC or CBC.

Whilst the powerlevel from an Intelsat transponder used for this purpose will not have a high EIRP, nevertheless, it is quite feasible to implement reception.

The next likely source of American television is likely to come from Ted Turners Cable News Network. This is already being supplied via a Pacific Intelsat to the Australian continent, and it has been rumoured for some time that he intends to beam his programmes into Europe, again possibly, via the Intelsat network.

At the present time the only American Domsat which one can view from the extreme west of Europe is the Weststar stationed at 79° West. This however, offers only an extremely low look angle, and would require an extremely large dish to put to any practical usage.

During the latter part of 1983 and into 1984, firstly the Hughes Galaxy 2 will be launched to 74° West, and then Spacenet 2 to 70° West. Whilst details of programming on the satellite is not available at the present time they will undoubtedly be used for some television feeds.

Yet again, we have the problem with these two satellites of an extremely low look angle, but undoubtedly successful attempts will be made to receive television from them.

European Television

The only likelihood of a major increase in programming in Europe on the 4 GHz band is the possibility of one of the major United Kingdom channels being supplied to the British forces in Germany via the Intelsat system. All other projected European television will be in the 12 GHz band.

The only exception to this could be the sometimes rumoured situation of a private consortium using a spare transponder on the Gorizont satellite system to supply a form of pirate television to Europe. However, it would appear very unlikely that such a capitalistic venture could co-exist on a communist system.

With the arrival of DBS television in Europe there will undoubtedly be the opportunity for specialised channels, and if the American domestic scene is anything to go by, one would be able to make a choice of 24 hours a day sports, news, weather, religion, education, cultural or many other subjects that the population of Europe would find useful and entertaining.

These specialised channels would not necessarily have to be dedicated to only one country, as it is technically very feasible to have the sound supplied on a number of different subcarriers, and therefore, in different languages to suit a very wide audience base.

At the same time the opportunity can be taken for supplying at last, a good quality sound to go with the vision and, of course stereo sound could be implemented with very little additional expense.

The opportunity could also be taken to supply a European teletexed service, which again could be transmitted in a number of languages.

It is interesting to note that the channel allocations made for the European countries are initially for five channels per country.

This gives countries such as Andorra, Monaco, Liechtenstein and Luxembourg a gross excess of television capability and undoubtedly the opportunity will be taken by one or more of these countries to implement a form of true European television appealing to the populations of all the countries within Europe.

Improvements in Equipment

At the present time the design and implementation of TVRO systems is still in its infancy.

As the market expands and more units are sold, there will undoubtedly be a larger investment in the R and D side of the business.

One of the major areas that will undoubtedly benefit will be in the design and implementation of the parabolic antennae, since at the present time the general efficiency levels quoted for the antennae and their associated feed horns is generally in the region of 55-60%. With modern Computer Aided Design (CAD) techniques a large advance in the level of efficiency can be expected.

Another area which is ripe for development is that of improving the video processing techniques in the satellite receiver.

By the application of custom designed integrated circuits, it should lead to considerably reducing the threshold of the satellite television receiver, thereby giving an overall systems improvement without resorting to larger antenna or lower noise LNA's.

It is to be hoped that the ingenuity of electronic engineers will assert itself, and that it will become possible to access the lower powered signals and receive good quality transmissions from them.

Five years ago it cost approaching one million pounds to implement satellite T.V. reception, and required an acre of land to site the equipment. Today the cost is reduced to a minute fraction of this, and it can be implemented in most households. The future should show many improvements.

T.V. TRANSMISSIONS IN VIEW FROM EUROPE

POSITION	PROGRAMMING	CHANNEL
60°E	OMAN	4A
	ALGERIAN	5A
	NIGERIAN	7B
53°E	RUSSIAN (CH1)	1
	RUSSIAN (CH2)	5
35°E	RUSSIAN (CH2)	5
5°E	FRENCH (T.F.1)	3
	SATELLITE T.V. LTD	4
11.5°W	FRENCH (T.F.1.)	4
	FRENCH NEWSFEEDS	3
14°W	RUSSIAN (CH1)	1
	RUSSIAN (CH2)	4
	CUBAN/INTERNATIONAL FEEDS	5
18.5°W	INTERNATIONAL FEEDS	12A/12B
	AMERICAN NEWS AND SPORTS	12A/12B
21.5°W	SAUDI ARABIA	1
	NIGER	3A
	SUDAN	7A
	ZAIRE	9A
	BRAZIL	6A/6B
24.5°W	INTERNATIONAL FEEDS	12A/12B
	BRAZIL	11B
27.5°W	MOROCCO	3A
	ARGENTINA	12
34.5°W	INTERNATIONAL FEEDS	12A/12B
	SPANISH (T.V.E.1)	7B
79°W	AMERICAN	2
	AMERICAN	5
	AMERICAN	12

SEE CHAPTER 9 FOR FULL DETAILS OF TRANSMISSIONS

APPENDIX 1

GLOSSARY

AFC (Automatic Frequency Control)

Circuitry used in a satellite television receiver that automatically locks on to the varying frequency signal, thereby preventing the receiver from going out of tune due to changes of temperature or variations in components.

AGC (Automatic Gain Control)

Circuitry used in satellite television receivers to adjust the amplification of the receiver automatically so that the output level will remain constant despite variations in signal levels that may be different from satellite to satellite.

AFN (American Forces Network)

A United States government controlled broadcasting service set up to provide radio and television to all members of the United States Armed Forces serving abroad. At the present time television is normally supplied from AFN in the form of video tapes, but they are in the process of changing over to direct transmission of live television via satellites.

Alignment

The process of adjusting an electronic circuit through the use of adjustable components, to maximise the sensitivity and signal receiving capabilities of the circuit.

AM (Amplitude Modulation)

The process of varying transmitted power output in direct relationship to incoming signal amplitude, this can be either audio or video. Amplitude Modulation is more susceptible to impulses of natural noise than FM (Frequency Modulation). Terestrial television normally transmits the picture using AM. However, satellite television systems use the FM technique for both sound and picture signals. A home satellite TV receiver then converts these signals to the standard format required by a normal television set.

Analogue

Continuously variable as opposed to being variable in steps (Digital). Signals that are analogue in nature include human speech, music and television pictures. Satellite systems, in use today, relay analogue signals back to earth by FM techniques.

ANIK

The Canadian domestic satellite system that transmits CBC (Canadian Broadcasting Corporation) network feeds throughout Canada. All ANIK satellites are operated by Telesat Canada of Otowa. There are at present five ANIK satellites in orbit with another one due for launch in 1983.

Antenna

A metallic or metallic coated device connected to a receiver that amplifies the high frequency signals that are received from the atmosphere. Depending upon the use and operating frequency, antennae can take the form of anything from a single piece of wire to a sophisticated parabolic shaped dish.

Apogee

The point in an eliptical satellite orbit that is furthest from the surface of the earth.

Arabsat

The Arab Leagues Regional Communications Satellites System. The first launch is planned in early 1984 with a second satellite a year later. It will be used for the transmission of telephone and data as well as television channels.

Attenuation

The process of reducing the level of the signal by means of an attenuator or by a natural process. Attenuators are passive devices used in a satellite receiver to compensate for excessively high signal levels.

Azimuth Angle

The angle of horizontal rotation that a parabolic antenna must be turned through to point to a specific satellite in a geosyncronous orbit. By taking the latitude and longitude, that the parabolic antenna is based at, the azimuth angle can be determined for any point on the surface on the earth. For convenience sake it is defined with reference to due north.

Baseband

The 6 MHz output signal from a satellite television receiver, video recorder or television camera. The baseband signal can be viewed directly only on a monitor. In order to display the baseband signal on a normal television set, a modulator is required to convert the baseband signal to a UHF television channel that the television set can be tuned to receive.

Bird

An American reference to a communication satellite. The satellite acts as an electronic mirror receiving signals fed to it from control centres, and re-transmitting the telephone, video and data signals to the earth via satellite terminals.

Blanking

The interval between picture frames displayed on the televison tube. A normal television signal consists of 25 separate but complete pictures or frames sent every second. They are received so rapidly that the human eye blends them together to form the illusion of moving pictures. This is the basis for television and motion pictures. A blanking interval is the portion of the television signal that occurs immediately after one picture frame is sent and prior to the next one being transmitted. During this blanking interval, data signals, for instance teletext, can be sent, but will not be picked up on a normal television receiver unless a decoder is fitted.

Carrier

The basic television transmitters signal is referred to as the information carrier. This carrier is modulated by altering either its amplitude or its frequency in relation to the video signal coming to the television. Satellite carriers are frequency modulated.

Carrier Frequency

The frequency on which a television station or microwave transmitter operates. Normal television station transmitters operate in the frequency range from 50 MHz up to 800 MHz. Microwave and satellite television transmitters operate in the band of from 1-6 gigacycles. (A gigacycle is one billion cycles per second).

Cassegrain Antenna

The use of a sub-reflector mounted at the focal point of a parabolic antenna which reflects energy to a feed located at the apex of the main reflector.

C-Band

The 4-6 GHz frequency band used by the domestic and international communication satellites. The signals transmitted to the earth are broadcast in the range of 3.7 to 4.2 GHz.

Channel

The frequency band in which a specific broadcast signal is transmitted. Television signals require approximately a 6 MHz wide frequency band in order to carry the necessary picture details, sound and colour coding.

Circular Polorisation

The international Intelsat satellites transmit their signals in a rotating corkskrew like, pattern as they are broadcast to earth. Both right hand and left hand polorised signals can be transmitted simultaneously and on the same frequency, thereby doubling the capacity of the satellite in numbers of communications channels.

Clark Orbit

The circular orbit in space 22,300 miles from the surface at which geosyncronous satellites are placed. First postulated by Arthur C Clark, August 1945, in an article published by Wireless World. Satellites placed in this orbit although travelling around the earth at many thousands of miles per hour are effectively stationary relative to any point on earth, as the earth itself is rotating at the same rate that the satellite is travelling around the earth.

C/N (Carrier to Noise Ratio)

The ratio of the power of a received satellite signal to the received noise as measured in decibels. The larger the ratio the better the television received. Broadly speaking if the C/N is below 7 dB the picture quality will be poor, above 10 dB the picture quality would be excellent.

Coaxial Cable

A transmission line in which a centre conductor is surrounded by a non-conductive material and then totally enclosed by an outer conductor or shield. Coaxial cables have an enormous capacity to carry high frequency signals and are used to connect the satellite TV antenna to the satellite television receiver.

Comsat

The Communications Satellite Corporation. Comsat launches and operates the international satellites for the Intelsat group of countries. It also owns and operates three 24 transponder domestic satellites used in the United States for television, telephone and data communications. These satellites are known as Comstar.

dB (Decibel)

A mathematical ratio developed by Alexander Graham Bell to express the relationship between two levels or signals.

DBS (Direct Broadcast Satellite)

The next generation of satellites designed to operate in the 12-14 GHz band. The high frequencies used by these DBS satellites have the advantage of allowing smaller antennae to be used, but there are still a number of difficulties involved with mass producing the very precise and complex electronics needed to receive the signal.

Demodulator

Part of the satellite receiver's circuitry that extracts the video and audio signals from the microwave transmission received.

Detector

A demodulation circuit used in a satellite television receiver in order to recover the audio and video signals from the microwave signals.

Digital

A digital signal has two states corresponding to two different signal conditions. For example a computer that was transferring binary information would shift between two frequencies to correspond the 1 and 0 logic states. Many satellites have special digital channels which are used for new's services, teletype etc.

Domestic Lease

A transponder lease on an Intelsat satellite which is used specifically for the broadcasting of television to one country. Morocco, Algeria and Nigeria are amongst the countries who use this system to distribute television throughout their countries.

Domsat

A domestic satellite. An American reference to the band of satellites placed over the United States which supply the programming from the three major networks and many other channels of television to local transmitters and cable television companies.

Down Converter

The circuitry in a satellite television receiver that converts the signal from the 4 GHz frequency to the more readily used 70 MHz range. Down converters are normally fitted at the dish immediately after the low noise amplifier, thereby allowing the 7 MHz signal to be run into the house with normal coaxial cable.

Down Link

The re-transmission of the television signal down to earth from the satellite in the 4 GHz frequency range.

Earth Station

The term used to describe the combination of dish antenna LNA down converter and receiver which is used to receive the signal transmitted by a satellite and converted to a suitable signal for display on the television.

ECS/Eurosat

The European Communication Satellite System. This comprises two satellites which will be working in the 12 GHz frequency range. It is planned that some television programmes, on a direct broadcast basis, will be transmitted from these satellites, but they are primarily intended for telephone and data traffic.

EIRP (Effective Isotropic Radiated Power)

A measure of the power of a satellite television signal received on earth. Prior to launch, satellite manufacturers will calculate EIRP signal strength when the satellites are tested before launch, and the data obtained is used to produce footprint maps showing the signal strengths to be received on the earth. There is a direct relationship between EIRP as received on earth and the required antenna size and specification of the LNA.

EL/AZ Mount

A metal structure, normally ridgidly mounted to the ground, to which the dish antenna is mounted. It enables the dish to be moved through elevation and azimuth, therefore allowing very precise aiming onto the satellites.

Elevation Angle

The upward tilt of a satellite antenna measured in degrees. When aimed at the horizon the elevation angle is zero, and if pointed directly overhead the antenna would have an elevation of 90 degrees.

Feed

The feed system of an antenna would consist normally of a feedhorn which is placed immediately in front of the LNA. In some circumstances it would consist of a sub-reflector, which would then reflect the signal into the feedhorn.

Feedhorn

An antenna component that collects the signal reflected from the surface of the dish and channels the signal into the LNA.

Feedline

A transmission line, normally coaxial cable, from the satellite dish to the receiver.

Field Strength Meter

A test instrument used in the television industry to measure the power of a signal in a transmission line or from a dish.

FM (Frequency Modulation)

The process of varying the frequency of a carrier wave in relation to an incoming signal, thereby modulating the carrier wave with the signal. When the modulated carrier is transmitted an FM television signal results.

FM Threshold

The point at which the input signal power is sufficiently strong enough to enable the receiver's demodulator circuitry to successfully detect and recover a viewable television picture from the incoming signal. Below the FM threshold a type of random noise, called 'Sparkies', begins to appear in the video picture.

Footprint

A map of the signal strength showing the EIRP contours as they cover the earth's surface. Different transponders on the same satellite will often have different footprints.

Frequency

The oscillation of an alternating current signal measured in cycles per second or hertz. At microwave frequencies radio signals take on line-of-sight characteristics and require focused antennae to be successfully received.

Frequency Reuse

The technique used to expand the capacity of a given set of frequencies or channels by separating the signals, either geographically or through the use of polarisation. American Domsats use vertical and horizontal polarisation techniques to reuse the same frequency on the same satellite. Intelsat and Russian satellites use circular polarisation techniques to obtain the same result.

Gain

A measure of the increase in level or strength of a signal normally measured in decimels. Gain is obtained from an antenna by virtue of its signal concentration capabilities, and from an amplifier because of its increasing the signal from a low to a high level by electronic means.

Galaxy

A system of three satellites to be orbitted by the Hughes Aerospace Corporation in 1983/84. Of particular interest in Europe will be Galaxy 2 to be orbitted in 1983, as it will be placed at 74 degrees west which will give an opportunity for TVRO users in parts of Europe to possibly receive T.V. signals from this satellite.

Geostationry/Geosyncronous (see Clark Orbit)

Gigahertz (GHz). One billion cycles per second. All signals operating above 1 GHz are referred to as microwaves and begin to take on the characteristics of visible light waves.

Global Beam

A satellite transponder downlink pattern, normally used by the Intelsat satellites, which effectively covers one third of the globe. These global beams are basically aimed at the centre of the Atlantic, Pacific and Indian oceans by the respective Intelsat satellites orbiting above the oceans. This enables all the nations on each side of the oceans to communicate with each other via the satellite. Because the transmissions are beamed to an extremely wide area, global beam transponders have a significantly lower EIRP output at the earth's surface compared with other beams.

Gorizont

A satellite system comprising a number of individual satellites run by the USSR for, amongst other usages, the rebroadcast of television. The most interesting is Gorizont 2 which is based at 14 degrees west and gives the strongest signal to be received over virtually the whole of Europe. Besides carrying Russian television it does, on a regular basis carry Cuban television and, on occasion, feeds of news programmes from Eastern Europe.

G/T (Gain over Noise Temperature)

The relationship in decibels between the gain of a dish antenna system and the surrounding ambient noise. As the number increases the picture quality improves. G/T can be increased by using an LNA with a lower noise temperature, or by increasing the size of the dish.

Guard Channel

A section of the frequency spectrum which is left between adjacent channels in order to prevent interference from one channel to the other.

Half Transponder

The normal frequency width for satellite transponder is 40 Megacycles. However, on the Intelsat satellites in some instancies, half the transponder, that is approximately 17 Megacycles is used for this television transmission, leaving the other half of the transponder free either for a second television channel or for transmission of telephone or data.

Intelsat

The International Satellite Consortium that owns and operates the global satellite communications system. Headquarters are based in Washington D.C. Intelsat's satellites carry telephone and television transmissions to all parts of the world.

Intersputnik

The Soviet Union's rapidly expanding international satellite network used to carry television and telephone communications between the major communist aligned countries.

Kelvin (K°)

The temperature measurement scale used by the scientific community. 0 degrees Kelvin represents absolute zero and corresponds to -459° F. The thermal noise characteristics of LNAs are measured in degrees Kelvin.

Latitude

An angular measurement of a point on the earth, above or below the equator. Zero degrees is represented by the equator, the North Pole by +90° and the South Pole by -90°.

LNA (Low Noise Amplifier)

An extremely sensitive pre-amplifier to which is attached the feedhorn of a TVRO satellie antenna. Its use is to strengthen the very weak satellite signal received. The most important parameter of an LNA is it's noise temperature as described in degrees Kelvin. The lower the noise temperature the better the signal quality will be. Typical LNAs will have a noise temperature of 100-120K°.

Longitude

An angular measurement of a point on the surface of the earth in relation to the greenwich meridian. The earth is separated in 360 degrees of longitude beginning at the greenwich meridian. As one travels west the longitude increases.

Microwave

A radio or television signal whose carrier is oscillating at a frequency in excess of 1 GHz.

Microwave Interference

A second signal, often stronger, received at the same time as a satellite television signal. This would normally be from a terestrial microwave relay transmitter.

Modulator

A device that modulates a carrier. A modulator would be used to convert the baseband television signal to the frequency of a UHF channel that a normal television could resolve.

Noise Temperature

The noise temperature of a LNA as expressed in degrees Kelvin represents the increase in noise added to the received signal due to the electronic processing of that signal in the LNA.

NTSC (National Television Standards Committee)

The television system in use in the United States which is transmitted at a scan rate of 30 frames per second using 525 horizontal lines per picture (sometimes referred to as "Never The Same Colour").

OTS (Orbital Test Satellite)

OTS is the test vehicle for the European Communications Project. It was designed to prove the feasibility of direct broadcast television service to Europe.

PAL (Phase Alternation System)

The European Colour Television System. PAL television picture format is 625 lines per frame, which provides a higher picture resolution than the NTSC system.

Parabolic Antenna

The most used satellite TV antenna. It takes its name from the shape of the dish described mathematically as a parabola. The function of the parabolic shape is to focus the weak microwave signals hitting the dish into a single focal point in front of the dish, it is at this point that the feedhorn or a sub-reflector is located.

Perigee

The point in an eliptical satellite orbit that is closest to the surface of the earth.

Polarisation

The technique used by a satellite designer to increase the capacity of the satellite transmission channels by re-using satellite transponder frequencies. The two main methods are horizontal and vertical polarisation, or left and right hand circular polarisation. In order to satisfactorily receive the signals a TVRO earth station must be fitted with a properly polarised feedhorn in order to select the correct signal.

Polar Mount

A mount for a dish antenna that enables the dish to scan the whole line of geosyncronous satellites by the rotation of the dish on its axis.

Satcol

A domestic satellite system for Columbia, to be launched in mid 1984.

Satcom

A series of dometic satellites owned and operated by RCA American Communications Incorporated. In 1983 Satcom F7 is due to be orbited and positioned at 66 degrees west which would give the possibility of a reception of some signal's in the European area.

Satellite

A smaller body revolving in orbit around a larger body in space. The moon is a satellite of the earth. Man made satellites travel in a large variety of orbits around the earth as the earth rotates on its axis. All the major communication satellites are placed into an geosyncronous orbit around the earth in order that reception from these satellites can be guaranteed 24 hours a day.

Satellite Receiver

A wide band FM receiver operating in the microwave range. It converts the incoming microwave signal to a standard baseband video signal for onward processing to a television set.

SECAM

The colour television system developed by the French, used also by the USSR Secam is transmitted with 625 lines per picture frame, but it is incompatible with the European PAL system.

Signal to Noise Ratio (S/N)

The measurement in decibels of the power or strength of a signal compared with the power of the noise in the signal. A high signal to noise ratio will give a better, clearer television picture. The signal to noise ratio of the television signal output from a satellite earth terminal will be determined directly by the carrier to noise ratio at the input and the threshold of the receiver.

SMA Connectors

A range of coaxial cable connectors that are designed for usage at the very high frequencies used by satellite reception terminals. Any signals that are being fed through coaxial cables in the 4 GHz or 12 GHz ranges must be terminated with this type of connector, as the normal connectors used in television or CB equipment will loose large amounts of the signal.

Sparklies

A form of interference which shows up on a television screen and is caused by a weak signal.

Spherical Antenna

The second major form of satellite television earth station antenna. A spherical antenna has the ability to see simultaneously and thus receive simultaneously a number of satellites in orbit.

Spot Beam

A focused transponder pattern used by Intelsat satellites in a limited geographical area. This enables a stronger signal to be received in the localised area chosen.

Sub-carrier

A second signal that is carried alongside the main signal in order that additional information can be transmitted. In satellite television transmissions the video signal is transmitted on the main carrier and the audio signal is sent via an FM subcarrier, which is located slightly above the video. Some satellite transponders have as many as four special audio or data subcarriers whose signal may or may not be related to the main programme being broadcast.

Subreflector

A small reflector used at the focal point of a parabolic dish in order to reflect signals into the feed.

Synphonie

A system of two satellites which have been orbited due to colaboration between France and the German Federal Republic. Transmitting in the 4 GHz band, they provide French television to terminals throughout Europe, Africa and the Middle East.

Threshold Extension

A technique used in satellite television receivers to improve the carrier to noise ratio threshold of the receiver. A receiver equipped with the threshold extension feature can make the difference between obtaining a viewable picture or a bad picture, because the carrier to noise ratio has been lifted above the threshold point.

Transponder

A combination of receiver, transmitter and antenna package which is physically part of a communcations satellite.

Uplink

The set of frequencies used by the satellite distribution centre earth station to transmit the video signal up to the satellite.

Waveguide

A metallic hollow pipe which is typically rectangular or oval in shape and used to carry microwave signals in and out of microwave antennae. The dimensions and tolerances of a waveguide are very critical.

Wind Loading

The pressure placed upon a satellite dish by the force of the wind. A well designed parabolic antenna should be capable of operating in at least 40-50 per hour winds without noticeable picture loss, and must be designed withstand winds in excess of 100 miles per hour.

COMPUTER PROGRAM FOR COMMODORE PGT
SATELLITE FINDER

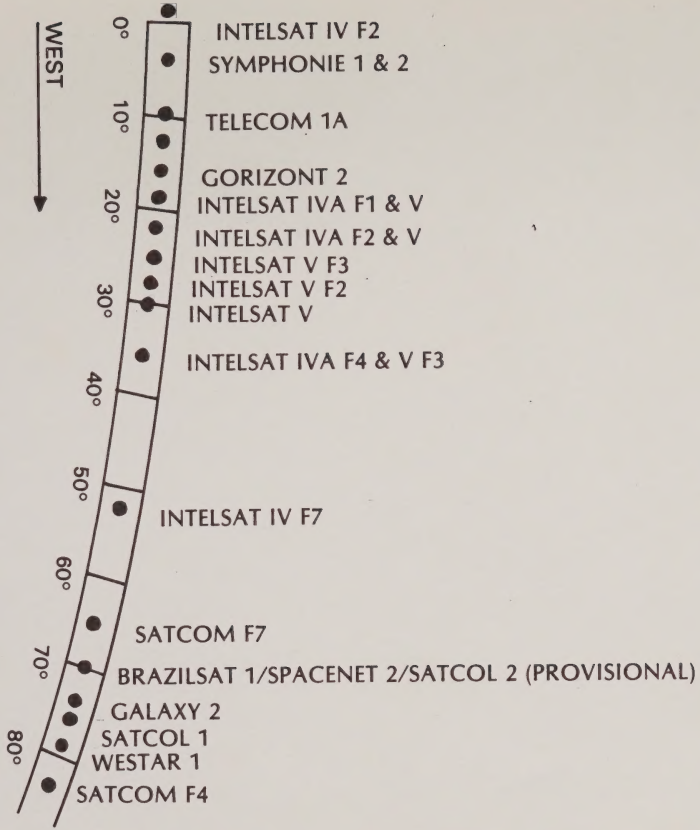
```
 10 A$ = "ENTER LOCATION LATITUDE. (DEGREES. DECIMAL DEGREES)".

 20 B$ = "ENTER LOCATION LONGITUDE. (DEGREES. DECIMAL DEGREES)".

 30 C$ = "IF LONGITUDE IS EAST ENTER AS MINUS VALUE".

 40 D$ = "ENTER SATELLITE LONGITUDE"

 50 E$ = "ELEVATION"

 60 F$ = "AZIMUTH"

 70 G$ = "DEGREES"

 80 PRINT A$ : INPUT A

 90 PRINT B$ : PRINTC$ : INPUT B

100 PRINT D$ : PRINTC$ : INPUT C

110 A=A* (PI/180) : B=B* (PI/180) : C=C* (PI/180)

120 D=B-C

130 X=180 + ATN (TAN D/SINA)

140 E=COSD * COSA : E=ATN (E/SQR (-E*E+1))

150 Y=ATN ((COSE -0.151269)/SINE)

160 X=X* (180/PI) : Y=Y* (180/PI)

170 PRINT E$ : PRINT X; F$

180 PRINT F$ : PRINTY; F$

190 END
```

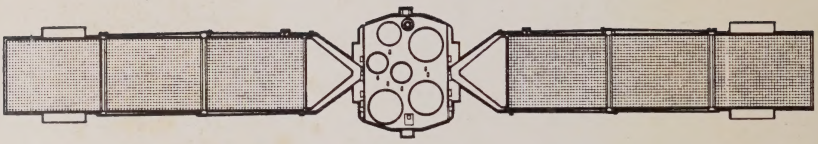
This program will work on most personal computers using "BASIC". Modifications to print statements may be needed to suit Syntax.

PROGRAM FOR CASIO FX602/602 PROGRAMMABLE CALCULATOR

P1 AZIMUTH	P2 ELEVATION	
MIN 3	MIN 3	=
ENTER LONGITUDE	ENTER LONGITUDE	
MINUS IF EAST	MINUS IF EAST	MIN6
MIN1	MIN1	MR5
ENTER LATITUDE	ENTER LATITUDE	÷
MIN2	MIN2	MR6
AC	AC	=
MR1	MR2	TAN^{-1}
-	COS	=
MR3	=	HLT
=	MIN2	
MIN4	MR1	WHEN ENTERING PROGRAM SITE
AC	-	LATITUDE AND LONGITUDE ARE
MR4	MR3	EXPRESSED IN DEGREES/DECIMAL
TAN	=	DEGREES IN POSITIONS NOTED
=	COS	
MIN5	=	TO RUN ÷
MR2	MIN1	INPUT SATTELLITE POSITION
SIN	MR1	(MINUS VALUE IF EAST)
=	X	PRESS P1 FOR AZIMUTH
MIN6	MR2	PRESS P2 FOR ELEVATION
AC	=	
MR5	COS^{-1}	
÷	MIN4	
MR6	COS	
=	=	
TAN^{-1}	-	
-	.151269	
180	=	
=	MIN5	
±	MR4	
HLT	SIN	

View of Satellite Belt from Great Britain


WEST
0°
10°
20°
30°
40°
50°
60°
70°
80°
INTELSAT IV F2
SYMPHONIE 1 & 2
TELECOM 1A
GORIZONT 2
INTELSAT IVA F1 & V
INTELSAT IVA F2 & V
INTELSAT V F3
INTELSAT V F2
INTELSAT V
INTELSAT IVA F4 & V F3
INTELSAT IV F7
SATCOM F7
BRAZILSAT 1/SPACENET 2/SATCOL 2 (PROVISIONAL)
GALAXY 2
SATCOL 1
WESTAR 1
SATCOM F4



Future Publications

Build A Parabolic Antenna & Mount	*(August '83)*
Build A Low Noise Amplifier & Feed	*(October '83)*
Build a Receiver/Down Converter	*(November '83)*